TUBERCULOUS INFECTION

in

INDUSTRIAL SCHOOL CHILDREN.

A CLINICAL STUDY, embracing the PHYSICAL EXAMINATION, VITAL CAPACITY, and RADIOGRAMS, of a GROUP of SIXTY BOYS.

T H E S I S

for the Degree of M.D., presented

by

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I N T R O D U C T I O N.

The views of medical men on the subject of Tuberculosis have passed through many changes since the original descriptions of Hippocrates. His descriptions of the advanced "consumptive" are as true to-day as they were then, but fortunately the picture is less frequently seen. Much progress has been made from the ancient attitude of hopeless morbidity, when tuberculosis was regarded as an incurable disease, demanding the exclusion of fresh air and sunlight in a mistaken attempt to alleviate the patient during the last phases of the disease. This view was based largely on a consideration of pulmonary tuberculosis, which is now regarded as a late visceral manifestation of the disease, the seeds of which are sown during childhood. This late visceral manifestation may be likened to the tertiary stage of Syphilis. From this hopeless morbidity we have passed to a stage of legitimate optimism, engendered by an accelerated decline in the death rate in the counties which have seriously tackled the great problem of eradication.

KOCH'S (1) discovery of the tubercle bacillus sets at rest the speculations as to the infective nature/

nature of the disease. This discovery was the starting point of extensive research work in all branches of tuberculosis. Perhaps too much attention has been paid to the seed - the bacilli -, and not sufficient attention has been given to the soil - the infected individual. Be that as it may, in recent years an increasing amount of attention has been devoted to the question of infection, specially the date at which it takes place. This research has brought to light the universality of infection in civilised communities. As a result, much thought has been expended on the best way to limit the spread of the disease.

It is perhaps an unpardonable platitude to repeat, at this stage of the Twentieth Century, that without infection there would be no tuberculosis. If, however, one comes to consider the tardy legislation in certain quarters, it is legitimate to ask whether the true significance of this simple fact is yet fully realised by responsible authorities. In proof of this one need only cite the difficulties to be overcome in classing tuberculosis as a notifiable disease, and the very grave delays which have taken place in dealing adequately with the milk question in relation to tuberculosis.

Another fact of fundamental importance is a realisation/

realisation that in civilized countries primary tuberculous infection takes place during childhood, in the vast majority of cases. It would appear hardly necessary to re-iterate this simple fact were it not obvious that the trend of health legislation has been slow to grasp, until perhaps recent years, the real significance of this truth. It is now generally accepted that a child is born free of tuberculous infection, despite the fact that it may be the off-spring of tuberculous parents. The infection is acquired post partum. It is, of course, admitted that cases of intra-uterine infection do take place at times, and have been reported in medical literature. Veterinary science has taken due cognisance of this fact. In Denmark bovine herds have been freed from tuberculosis by an appropriate application of this fact. Calves, born of tuberculous cows, are separated at once from their mothers and grow up free from tuberculous infection.

There is another pathological fact which bears repetition, as its fundamental significance is not yet fully appreciated. Tuberculosis, or tuberculous infection, is essentially a primary lymphatic glandular process. This has been proved times without number in experimental animals, and the same holds good/

good in human pathology. It has been demonstrated clinically as well as in the postmortem room. This question of primary lymphatic involvement is apt to be forgotten, as massive infection may take place in the early years, obscuring the primary lymphatic involvement by a rapid and extensive spread to other tissues.

From a period shortly after birth there is a high infant mortality from tuberculosis, till about the fifth year of life. This is followed by a marked fall during the school age. From adolescence onwards there is a gradual rise in mortality, up to about the thirty-fifth or the fortieth years, after which a fall again takes place. If this curve be studied in relation to the type of mortal tuberculosis, it will be seen that in the earlier ages death takes place from a more generalised type of tuberculosis than is present in the adult.

Many factors are probably at work to explain this varying age incidence mortality. In the early years of life the risk of contamination is much enhanced; the opportunities among the industrial classes for fresh air and sunlight are small, where their young children are concerned. Further, it is obvious that the tissues of infants are more succulent and less resistant than in older children and adults. Infectious diseases/

diseases are also common at this age. During school age, the child leads a more disciplined life and has less direct contact with the floor of the house. There is, also, more opportunity for fresh air and exercise, with a corresponding increase of resistance in the tissues. When adolescence is reached, there is an increased strain, with harder work and possibly less fresh air. In many walks of life also, there is an increased risk of infection, or of the rekindling of some latent infection, due to some other intercurrent disease.

Sir ROBERT PHILIP (2), as is well known, has always advocated the vital importance of regarding childhood as the "seed time" in the natural history of tuberculosis in the human race.

In 1910 the promoters of an important Tuberculosis Conference in New York State, submitted their programme of anti-tuberculosis operations, to be followed in the State, during the following ten years, to Sir ROBERT PHILIP, and asked him to cable his view, as to the probable outcome in 1920. The following cablegram was despatched:- "Prosecute great programme proposed: watch child as potential tuberculous seedling - correct faulty compulsory environment and expect 40 per cent reduction by 1920, and practical disappearance within a generation and a half". The result was, as/

as Sir ROBERT PHILIP pointed out, in his address to the fourth conference of the International Union against Tuberculosis at Lausanne last year, a drop of more than 35% in New York State, despite the difficulties encountered during the War years. In New York City, the drop was of an even greater degree.

Sir ROBERT PHILIP has frequently pointed out at medical conferences, how simple it is to detect the time of infection, by an application of the Tuberculin test. From this aspect, he has urged a closer control of children, so that means can be taken to combat possible, later disasters, by care and caution in building up resistance at a stage when the human organism normally shows evidence of increasing powers of resistance.

Infection, which can produce immunity to secondary infections, is much to be desired. A large percentage of the population acquires such immunity accidentally. Our aim should be, to try to eradicate infection altogether, but at present this is hardly practicable. In the absence of such a state/

state of affairs, as complete eradication, a suitable protective inoculation has much to recommend it. This protective inoculation has been advocated by CALMETTE (3) during past years, and has been demonstrated by him with some success in newly born calves.

Three years ago, in opening a discussion on Tuberculosis at School Age, at the Third Conference of the International Union against Tuberculosis, at Brussels, the writer made bold to suggest, following the teaching of Sir ROBERT PHILIP, that the School rather than the Hospital, should be made the starting point of clinical research into tuberculous infection. In this sphere, infected children could be noted, and investigations set on foot, to discover the possible source of infection, by visiting the home and noting the varied activities of other members of the family.

The investigations embodied in this thesis, were carried out on a small group (Sixty) of Schoolboys who came from industrial homes, where poverty was definitely present, and was a factor in selecting the boys for admission into this particular school. They were examined from the point of view of Tuberculous infection, in relation to Vital Capacity, Physical Examination and Radiographic Findings.

LYMPHATIC/

LYMPHATIC GLANDULAR INFECTION.

I. PATHOLOGICAL EVIDENCE.

The importance of glandular infection of tubercle bacilli has already been mentioned, and it is necessary to give a short summary of certain views on this subject, as considerable attention has been paid to this matter in the clinical investigation of the cases reported in this Thesis.

It is not proposed to re-open the vexed question of the air passage or alimentary passage source of infection. Suffice it to say that in the past, perhaps, too much has been made of this rather academic question. The truth may lie mid-way between these two extreme views. Both channels may be involved in allowing the passage of the bacilli through their respective mucous membranes. Bacilli pass through mucous surfaces without leaving any trace of an abrasion, again complicating the issue. COHNHEIM'S (4) view, as to the production of a tuberculous lesion at the point of inoculation, can no longer be maintained.

ORTH (5) in 1876 was the first to draw attention to the fact that the macroscopic appearance of a gland might not indicate tuberculosis, and yet microscopical/

microscopical evidence could be obtained. LOOMIS[6] found 26.6% of what he termed "latent bacilli carriers" in post mortems on so-called non-tuberculous people. He used rabbits for the inoculation of the glandular material. PIZZINI[7] carried out a similar line of investigation, using guinea pigs as the inoculated animals, and showed 42% positive cases in glands which appeared normal macroscopically. KALBLE[8] was the first to demonstrate that the histological appearance of a gland might show no tuberculosis, yet tubercle bacilli could be recovered by animal inoculation. MCFADYEN & MACCONKEY[9], HARBITZ, WEICHESTAUM & BARTELS[10], ROSENBERGEN[11], have also shown live tubercle bacilli in glands which appeared to be non-tuberculous on macroscopic or microscopic examination.

HARBITZ[12] conducted an extensive research into the occurrence of lymph node tuberculosis in childhood and adults. He examined the glands from a series of 142 children and injected guinea pigs with material from these glands with the result that in 91 cases showing no tuberculosis by macroscopic or microscopic examination, 18 gave rise to tuberculosis in the inoculated animals. In other words, 20% of the cases passed as negative without animal inoculation proved to harbour live tubercle bacilli.

The/

The above remarks refer to glandular infection in general. Much investigation of a more particular type has been carried out to trace, if possible, the mode of carriage of the infection once the bacilli have established themselves in the tissues, principally in the lymphatic structures.

PARROT (13) asserted that there could be no tracheo-bronchial tuberculosis without an original pulmonary lesion. This view has been known as PARROT'S LAW - the law of similar adenopathies. This position has been backed up by the work of KUSS (14), GHON (15) and others. Their observations were based on macroscopic findings in postmortems on children and young adults. They held that the lung lesions found were to be regarded as the chancres of inoculation.

CALMETTE, GUERIN & DELEARDE (16) have however demonstrated tubercle bacilli in tracheo-bronchial glands in infants dying from non-tuberculous diseases where no clinical or postmortem evidence of a pulmonary tuberculous lesion could be found. ROBINOWITSCH (17) confirmed these findings in another series of cases.

CALMETTE (3) points out that erroneous conclusions have been drawn from these observations of GHON (15) and KUSS (14), and that there is no justification for their assertions. He therefore considers PARROT'S LAW/

LAW valid only if it be inverted!

Several very careful studies on the relationship of tracheo-bronchial infection have been carried out in the United States of America, and go to a large extent to support CALMETTE (3) and his school in their view about the stages of infection.

KRAUSE (18) describes the results of certain experiments carried out with the well-known Turdeau culture RI, which had lost its original virulence, but had become "stabilised" as to its degree of minor virulence. In other words, this strain of tubercle bacilli, originally obtained from a cadaver, dead of miliary tuberculosis, had not lost its virulence completely, but had reached a stage where its virulence for laboratory animals was singularly stationary and of a mild degree. He demonstrated how the lymphatic system became affected from a primary inoculation with surprisingly little tubercle development in the lungs, despite well marked lesions in the tracheo-bronchial glands. He demonstrated conclusively that tracheo-bronchial tuberculosis in guinea pigs could exist without pulmonary involvement. He adds "the presumption is strong that the same event occurs in human beings." This reminded him of CORNET'S (19) experiments with attenuated organisms in dust, where tracheo-bronchial/

bronchial tuberculosis was set up without tubercles being detected in the lungs. This view is directly opposed to GHON'S (15) primary lung focus thesis, which KRAUSE (18) says is open to severe criticism. He points out that much difficulty must arise in estimating the priority of a lesion when comparing two such different tissues as lungs and lymph glands. KRAUSE (18) reminds his readers that tracheo-bronchial nodes can only receive tubercle bacilli from two routes, viz., bronchial arteries and pulmonary lymphatics, the evidence being overwhelmingly in favour of the latter. Every facility is offered the bacilli, which may gain the lungs by any route whatever, to concentrate themselves on the tracheo-bronchial nodes. Much has been written about resistance of certain tissues to tubercle bacilli, but KRAUSE (18) points out that divergence of anatomical factors may be sufficient to explain such differences. He concludes this article by stating "The micro-organisms tend to accumulate in lymph nodes in sufficient numbers to produce lesion, while in the viscera the bacilli are so distributed that not enough locate at single points to set up visible tubercle. To substantiate this view I might add that when I inoculated guinea pigs with successive doses of large numbers of RI, I almost invariably succeeded in producing/

producing nodules in the spleen and lungs. At any rate, when we infect our animals with bacilli, such as RI, and avoid the confusing effects of wide-spread and rapidly progressing disease, which is brought about by more virulent bacilli, and which tend to obscure our effort to unravel their meaning, we begin to appreciate the importance of anatomic relations in determining the course of infection; and it is largely for this reason that I have been at such length in describing the effects of RI."

In a later publication KRAUSE (18) gives a detailed account of the anatomy of the guinea pig lymphatics, and points out that the tracheo-bronchial nodes are comparatively large in this animal, and that they drain the lungs alone. He also reminds his readers that the guinea pig is a "thin pleura" animal, has an unusual amount of muscular tissue in its bronchi and vascular structures, possesses enormous calibre of peribronchial and perivascular lymphatics, and has relatively little intra-pulmonary lymphatic tissue. He, therefore, considers that lymphatic drainage must be active and free, differing from the structure of the human lung to be referred to later. In this connection it may be of interest to state that KRAUSE (18) has also pointed out the large number of Malpigian bodies/

bodies, which are simply lymphoid tissue, in the spleen of the guinea pig, when compared to that of man or even the rabbit. This is probably the most important explanation of early spleen infection in experimental inoculations of the guinea pig.

ROGERS (20) has shown experimentally the same early involvement of the tracheo-bronchial nodes in the guinea pig without demonstrable tubercles in the lung.

WEBB, RYDER & OLCOTT (21) carried out guinea pig experiments to show the lymph node distribution and conclude that :-

"Subcutaneous inoculation of tubercle bacilli in the guinea pig is followed by early development of lesions in the lymph nodes in various remote regions of the body, often without any lesions of the areas draining into these nodes being apparent, either at the same time or later. The nodes in which lesions have been demonstrated include the inguinals of the side inoculated, primary inguinals of the other side, iliacs, aortics, axillaries, two groups of cervicals, retro-sternals, tracheo-bronchials, hepatics, mesenterics and ileo-caecals"

It is always questionable if one is entitled to apply observations made on small experimental animals/

animals to human pathology, but a good deal of opinion is in favour of a close analogy between the experimental animal and the human in relation to this question of distribution of tuberculous infection. Tuberculosis should be regarded in the human as primarily a lymphatic disease - the essential clinical characteristics being found in childhood. OPII & ANDERSEN (22) point out that tuberculous lesions which occur in the lungs of adults, who die from causes other than tuberculosis, assume the childhood type, and are, of course, healed. Such evidence of primary infection is found in the substance of the lung with focal lymphatic lesions. Apical lesions, when found, assume the characters of a secondary infection with no tendency to cause caseous tuberculosis of adjacent lymph nodes. In the series investigated, apical lesions were seldom seen before 10 years of age, after which there was a steady increase in the adult type of lesion. Their method of investigation consisted in taking X-ray photographs of the lungs after removal from the body. They regarded the calcified areas, which these photographs demonstrated, as evidence of the distribution of the primary childhood infection. They divided the cases into four groups, based on the amount and distribution of the calcified areas. In a series of 86 cases, they only found 7 where no lesion was noted by the X-rays. The authors/

suthors are careful to point out that absence of calcified lesions, does not, necessarily, exclude tuberculosis.

It seems a little difficult to reconcile the views of GHON (15) and KUSS (14), with those of CALMETTE (3), KRAUSE (18), and others - they seem to be so totally divergent. It is, however, possible that the views expressed by these authors, are hardly fit subjects for comparison, because their methods of approaching the subjects, are totally different. GHON (15) dealt with human morbid anatomy in subjects whose tuberculous lesion was fully developed or healed, where anatomical relationships are totally different from those of laboratory animals. CALMETTE (3) and KRAUSE (18), dealt with experimental animals, or patients (CALMETTE) who were regarded as non-tuberculous, except for a glandular lesion discovered at post mortem. In the latter case, they had the opportunity of tracing the development of tuberculous lesions from their beginnings, while GHON (15), dealt with fully developed cases. It is, admittedly, difficult to estimate priority of lesion, when one is dealing with two such different structures as lymphatics and lung tissue. GLOYNE (23), pointed out the extreme difficulty he encountered in tracing the path of infection in a lung, by the study of its lymphatics. It is also worthy of note - as will be pointed out later - that human lungs are/

are well supplied with lymph nodes, and these structures may act as 'rests' to the passage of bacilli from the pulmonary veins. There seems to be no reasonable doubt that bronchial gland infection must come from pulmonary or pleural lymphatics. The bacilli must enter these lymphatics by the air route or through the venous circulation. It has been suggested by GLOYNE (23) that tubercle bacilli may reach the tracheo-bronchial nodes through an anastomosis between the broncho-mediastinal lymphatics and the thoracic duct, although he submits no proof of the presence of this path.

LYMPHATIC GLANDULAR INFECTION. (Contd.)

II. CLINICAL.

HARBITZ (12) states that VOLLAND (24) was possibly one of the first to investigate the frequency of lymph nodes in children. VOLLAND found that 94% of children between the ages of seven and twelve years showed enlarged cervical lymph nodes. He certainly hesitates to regard all these nodes as tuberculous, yet/

yet he believed that such an infection existed in many of these cases. HARBITZ (12) also quotes LASER (25), who likewise investigated a series of 1,216 school children and found 1,079 showed enlarged cervical lymph nodes. He concluded on clinical grounds that from 32.4% - 58.9% of the cases were due to tuberculosis.

SIR ROBERT PHILIP (2) has urged the necessity of a much more thorough search of the glandular areas of the body than is usually carried out. The writer remembers well, while a resident physician to the Children's Hospital in Edinburgh during 1909, a visit paid by SIR ROBERT PHILIP to this Hospital, and how he pointed out the vast significance of a thorough search in all the glandular areas of the body. He demonstrated to the staff the presence of cervical lymph nodes in many, if not all, of the in-patients. He drew attention to the fact that the presence of a multiplicity of small - almost tiny - supra-clavicular lymph nodes was just as significant as the presence of large lymphatic glands, as part of the cumulative evidence in determining tuberculous disease, or at least infection. His views at that time met with rather a cold reception. It was argued, by the staff of the hospital, that many other causes of enlarged cervical nodes might be at work, and it was difficult

to/

to accept the statement that all enlarged glands were probably tuberculous. Since then, however, evidence has accumulated to show that the view expressed at that time has been amply justified.

The clinical determination of enlarged thoracic glands has been extensively studied. It is no easy matter to give a precise opinion as to their presence or absence. Further, if one suspects them of being enlarged, it is not always easy to say such enlargement is due to tuberculosis. Some claim that an X-ray of the thorax can clear the matter up as to enlargement, but it will be shown that this is not by any means an easy matter. Apart from interpretation of the X-rays, photographic technical errors may in themselves cause much dubiety as to the correct interpretation to be placed on a radiogram.

Sufficient reference has been made in a general way to prove, both on pathological and clinical grounds, that the investigation of the glandular system is well worthy of attention. It is questionable if the true significance of glandular infection is yet fully appreciated by those who have the medical welfare of industrial children in their hands. The reports of medical officers of schools give one the impression that tuberculosis is not a common condition/

condition. We find, however, a very different state of affairs, when we turn to the observations made by the tuberculin test, and at post mortems.

This discrepancy is, perhaps, to be accounted for, by the establishment of different points of view, and different diagnostic standards. The school medical officer is concerned chiefly, with noting gross defects, obviously interfering with the child's education, e.g., eye defects, asthenia etc. The Pathologist and the Pediatrician look at the question, more from the point of view of scientific investigation, with the special object in tracing the paths of infection, or the date at which infection took place, thus dealing with far reaching, practical issues.

Debility is a common and convenient term to express lack of health in an individual, when the cause of this state of affairs is not clearly obvious. There are many causes of debility, e.g., Rickets, lack of adequate food, improper hygiene, etc., but it is more than likely that due weight has not yet been given to tuberculosis in childhood as a debilitating factor.

From the above pathological and clinical survey, it is perfectly obvious that the lymphatic system is much affected in the course of primary infection with tuberculosis. Primary infection, for the most/

most part, takes place in childhood. It, therefore, becomes obvious that the investigation of the glandular system is of paramount importance in the search for evidence of tuberculosis in childhood. It is only by making a systematic search for early evidence of tuberculosis that a rational form of therapy can be carried out. If evidence of infection, and its debilitating consequences, can be noted early, a very slight alteration in the mode of life of a child may be all that is required to save much time, weariness of soul and expenditure of money at a later date.

The writer decided, therefore, to study a group of industrial school boys, who were perfectly well in the sense that they were able to carry on the normal school routine. Infection can be detected by a tuberculin test, but it is well known that many children with a positive reaction are often more robust than those who show a negative reaction. It was, therefore, decided to make a very full physical examination, which would include Vital Capacity Tests and Radiograms of the Thorax, in addition to a routine Pirquet Test. It was hoped by this means to find some co-relationship of phenomena which would act as a guide in estimating individual disability from the point of view of tuberculosis. At the same time, it was/

was hoped to obtain some general idea of normal standards, or at least what deviations might be regarded to be within normal limits.

Previous to the commencement of this clinical investigation, the author was unaware of any work which had been undertaken on similar lines, but since these investigations were completed in the summer of 1922, he has seen several articles dealing with this question, although, perhaps, not in such a detailed way as was here attempted. In other investigations larger numbers were employed, and two or three of the phases of physical examination were used, but not all four as here undertaken. There was more "team work" in these other observations, while in the present series of investigations there was less of the "team work" element, and in consequence, a much smaller number of cases investigated - sixty in all.

The body of the thesis commences with a short anatomical review of certain human lymphatic structures, viz.,- the cervical and thoracic. This is followed by certain observations on the lymphatic flow. Then follows a short review of Vital Capacity and the Pirquet Test. The details of the physical examination are then discussed with special reference to spinal auscultation. Radiographic examination of the thorax is/

is briefly touched upon, and a detailed description, with charts and X-ray photographs, is given of all the cases examined. In a certain proportion of the cases, radiograms were not carried out, as the children could not co-operate in this part of the examination. Finally, tables are given showing certain results of the investigation and conclusions drawn from the findings obtained.

THE LYMPHATIC GLANDULAR SYSTEM.

The clinical observations on which this thesis is based, include the physical examination of the cervical, axillary and pulmonary, glandular regions. It is, therefore, necessary, to review briefly certain anatomical and physiological facts relative to the lymphatic circulation in the neck and thorax.

THE LYMPHATIC SYSTEM of the HEAD and NECK.

The following anatomical account is based largely on the standard work of POIRIER. (26)

The lymphatic glands in this region of the body are conveniently divided into two groups viz:-

I. Circular - and

II. Vertical.

The former is situated close to the junction of the head with the neck; the latter is placed, more or less at right angles to the circular group, and proceeds downwards, in chain-like fashion, beneath the sterno-mastoid, in relation to the large vessels of the neck. This latter group terminates by passing into the thorax, where the neck and upper part of the chest meet. This vertical group of glands is joined by many collateral branches, which are of less importance.

I./

I. CIRCULAR GROUP of GLANDS.

(a) SUB-OCCIPITAL:

These glands rest on the complexus muscle, external to the external border of the trapezius muscle, being sub-aponeurotic. They drain the occipital region of the hairy scalp, and their efferent lymphatics pass downwards and forwards, to reach the highest glands of the sterno-mastoid group.

(b) MASTOID: (RETRO-AURICULAR). These glands lie on the mastoid insertion of the sterno-mastoid muscle. They drain the temporal region of the hairy scalp, the internal surface of the auricle, with the exception of the lobule, and the posterior surface of the external auditory meatus. The efferent lymphatics pass into the superior sub-sterno-mastoid glands.

(c) ANTERIOR-AURICULAR: There may be only one gland in this region which is situated beneath the parotid fascia in front of the tragus. This gland (or small group of 2-3 glands) drains the root of the nose, eyelids, anterior part of the scalp and the anterior part of the external ear.

(d) PAROTID: These glands are intimately linked up with the pre-auricular gland, and lie in the body/

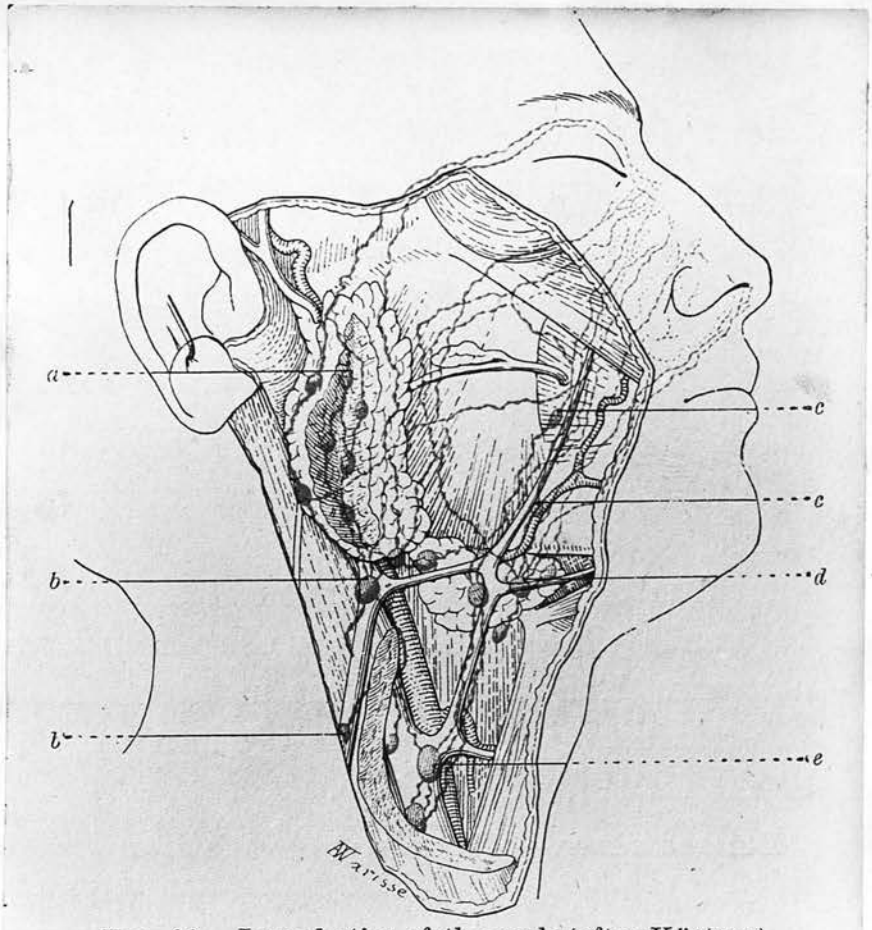


FIG. 99.—Lymphatics of the neck (after Küttner).

(From POIRIER)

a = Parotid gland.

b = Glands of external chain.

c = Facial gland.

d = Submaxillary gland.

e = Gland of internal chain.

body of the parotid salivary gland. A small and special group of these glands form a short chain, along the anterior border of the sterno-mastoid muscle. They drain practically the same area as the pre-auricular glands. These groups of glands also send their efferent lymphatics into the sub-sterno-mastoid glands.

(e) SUB-PAROTID: These glands are placed between the parotid gland and the pharynx, and are in contact with the carotid and jugular veins. They drain the nasal fossae, naso-pharynx and eustachian tubes. Their efferent vessels pass into the deep cervical chain.

(f) SUB-MAXILLARY: These glands lie in the digastric triangle and stretch along the inferior border of the mandible, between it and the sub-maxillary salivary gland. They are all under the fascia. They drain the cheek, the nose, upper lip, external aspect of the lower lip, the gums and the anterior third of the lateral aspect of the tongue. Their efferent vessels cross the hyoid bone and pass into the deep cervical chain.

(g) FACIAL: In close association with these sub-maxillary glands, are a group known as Facial glands. The inferior group is situated on the external surface of the mandible, in front of the anterior border of the masseter muscle, in close apposition to the facial/

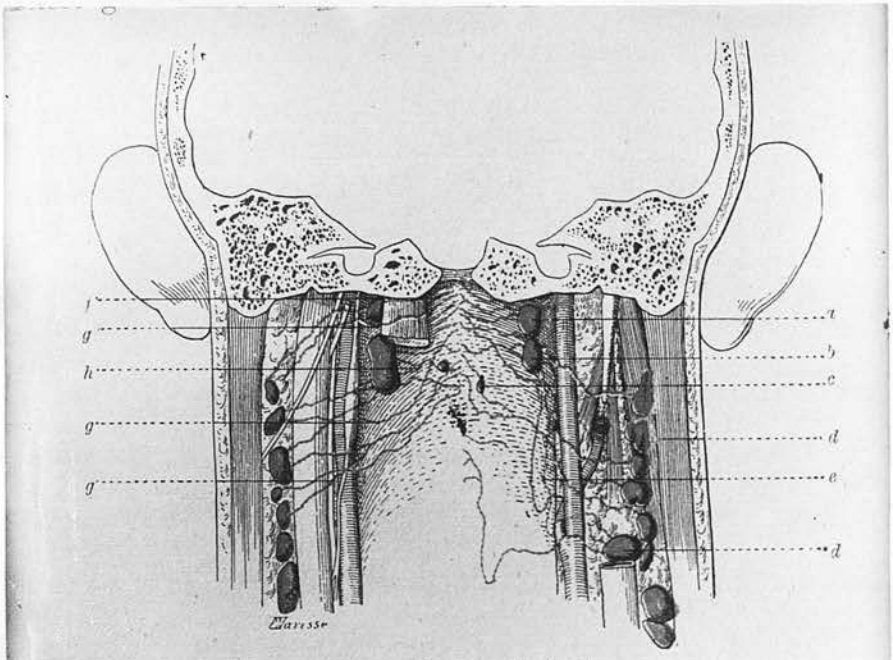


FIG. 96.—Retro-pharyngeal glands.

(From POIRIER)

ab = Retro-pharyngeal glands.

d = Gland of deep cervical chain (external group)

g = Lymphatic vessel of pharynx passing directly to gland of deep cervical chain.

h = Afferent lymphatic of retro-pharyngeal glands.

facial artery. Two other groups are situated higher up in the face, along the line of the facial artery. These glands send efferent vessels to the sub-maxillary group.

(h) SUB-MENTAL: This group includes glands situated in the triangle, bounded laterally by the anterior bellies of the digastric with the hyoid bone as its base. The sub-mental group really includes glands, often termed sublingual, which lie between the genio-glossi muscles, resting on the hyoglossus. They drain the integuments of the chin and the central portion of the skin of the lower lip, and the corresponding portion of the mucous membrane of the mandible, the floor of the mouth and the tip of the tongue. Some of the efferent vessels go to the submaxillary glands, and others to a gland on the anterior surface of the internal jugular vein, above the point where the vein crosses the omo-hyoid muscle.

(i) RETROPHARYNGEAL glands are placed behind the pharynx, at the junction of its posterior and lateral surfaces, at the apex of the lateral masses of the atlas. They drain a wide area, which includes the mucous membrane of the nasal fossae, the naso-pharynx, the eustachian tubes, and the cavity of the tympanum. Their efferents pass into the superior glands of the internal/

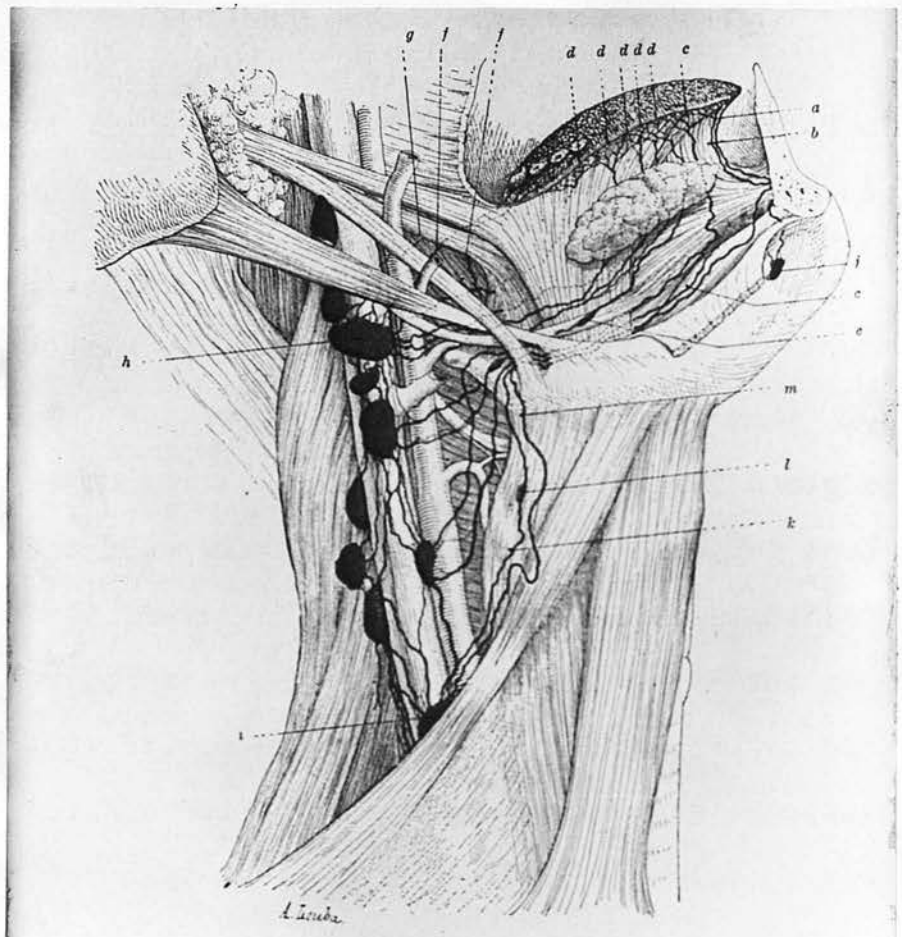


FIG. 105.—Lymphatics of the tongue, anterior view (Poirier).]

(FROM POIRIER)

LYMPHIC VESSELS from the TONGUE.

They drain into the deep or internal group of cervical glands. The tonsillar gland is seen between the stylohyoid and posterior belly of the digastic muscle. Below this, is seen the internal chain with the supra-omo-hyoid gland just appearing above the upper border of that muscle.

internal jugular chain, passing for the most part behind the large vessels and nerves.

II. THE DESCENDING CERVICAL CHAINS.

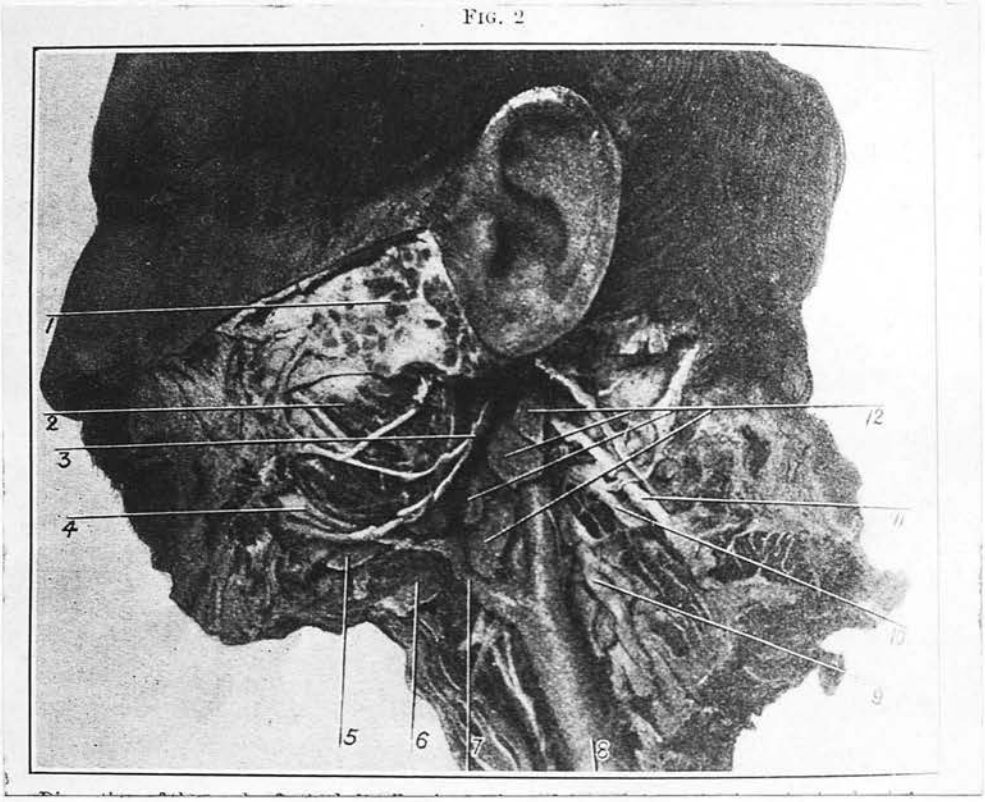
There is no doubt that this part of the lymphatic glandular system of the body, is one of the most important regions, in relation to any form of bacterial infection. It is specially so, in regard to infections of the tubercle bacilli, and, therefore, requires a rather more detailed description as to its anatomical relations, more particularly as to its efferent and afferent vessels. Some departure will, therefore, be made in terminology from POIRIER'S (26) anatomical description, and the description given by G. B. WOOD (27) will be followed, as he lays due emphasis on certain points with special bearing on tuberculous infection. The deep cervical glands form a broad chain lying beneath, and just posterior to, the sterno-mastoid muscle from the transverse process of the atlas above, to the root of the neck below. This chain of glands is conveniently divided up into: -

FIRSTLY:-

(a) an external group, and -
(b) an internal group.

SECONDLY:/

FIG. 2



(FROM G. B. WOOD.)

1. Parotid gland.
2. Masseter Muscle.
3. Facial Nerve.
4. Facial Artery.
5. & Submaxillary Lymph and Salivary Glands.
6.
7. Facial Vein.
8. Internal Jugular Vein.
9. Brachial Nerve Plexus.
10. Superficial Cervical Plexus.
11. Spinal Accessory Nerve.
12. Internal Jugular Lymph Glands.

SECONDLY:- a further division has been suggested by STILES (28) into

(a) upper - and
(b) lower groups, -

the dividing line being the anterior belly of the omo-hyoid muscle.

(a) External Group (Superior): The glands constituting this sub-group, are placed posteriorly, and rest on the splenius capitus muscle, levator anguli scapulae and scalene muscles. They are continuous with the inferior group, lying below the anterior belly of the omo-hyoid and form the supra-clavicular group of glands.

These groups of glands drain the posterior part of the head and neck, and therefore, receive vessels from the mastoid, sub-occipital, part of the auricle and the scalp above these glands, the pharyngeal tonsil, which drains the posterior aspect of the nasal fossae, its surrounding structures, and the vault of the pharynx. It also sends afferent vessels to the posterior chain. G. B. WOOD (27) describes the path from the pharyngeal tonsil, thus:-

"Running posterior from the lower part of the pharyngeal tonsil, the vessel penetrates through the posterior pharyngeal wall, entering the retro-pharyngeal space; then it runs downwards and outwards, just below the insertion of the rectus capitis anticus/

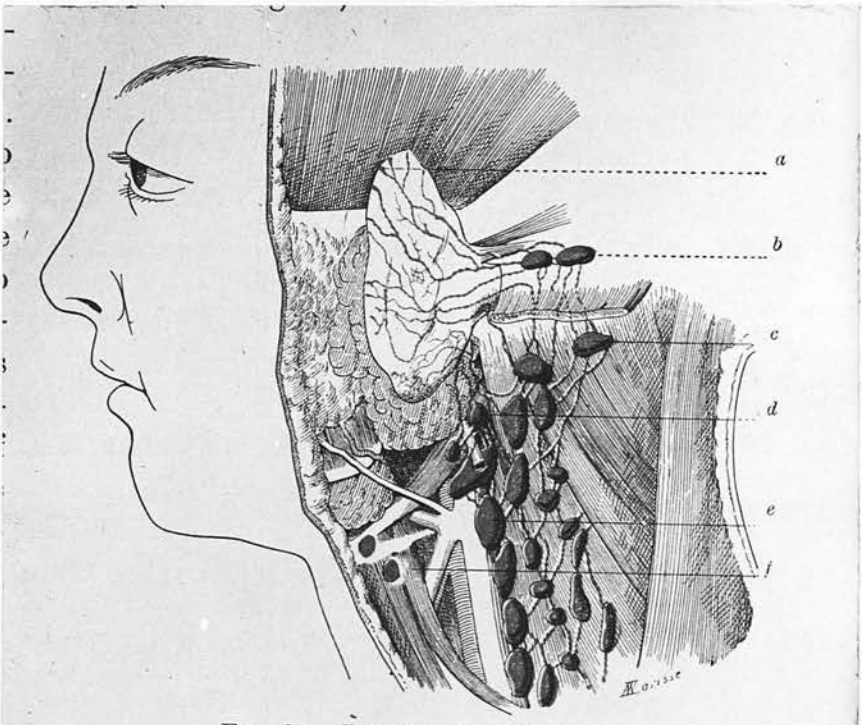


FIG. 97.—Deep Cervical Chain.

a. Collectors of the fossa of the auricle.

b. Mastoid glands.

c. Sterno-mastoid gland (expernal group).

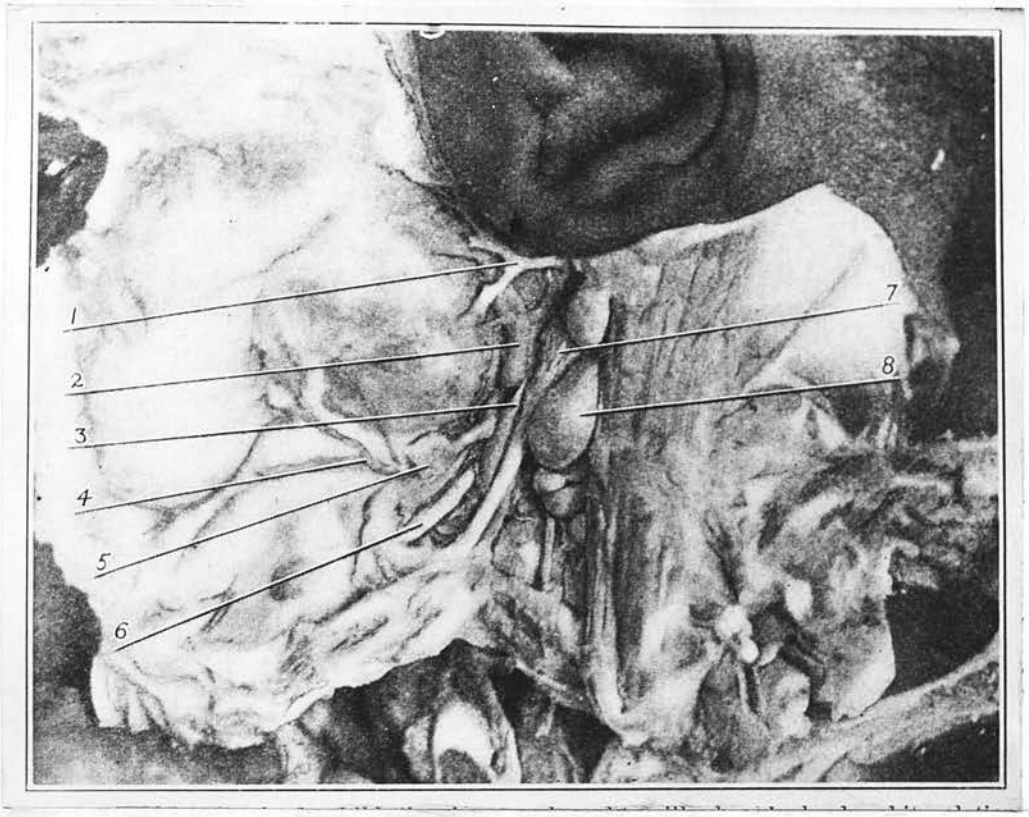
d. Glands of the external jugular chain.

e. Glands of the internal jugular chain.

anticus major, and between this muscle and the bodies of the cervical vertebrae; still running obliquely downwards and outwards, it passes between the sheath of the great vessels of the neck, until it reaches a position almost opposite the posterior border of the sterno-mastoid. It then turns directly outwards, and enters one of the small glands situated just below the tip of the mastoid, along the posterior border of the sterno-mastoid muscle".

It may appear unnecessary to go into such detail as to lymphatic distribution, but it cannot be too strongly emphasised, that a thorough understanding of lymphatic distribution in the neck, must be the first basal fact in grasping the significance of tuberculous infection in children, for, as has already been mentioned, tuberculosis in young people is essentially a disease of the lymphatic system - a fact which is not yet, quite sufficiently appreciated by those who have the responsibility of the medical supervision of children.

The efferent vessels, from this upper external group, pass into the supra-clavicular glands, lying in the sub-clavian triangle. These glands also receive efferent vessels from the arm, including the axillary glands and mamma. They receive no direct vessels from the mediastinal glands.



(FROM G. B. WOOD)

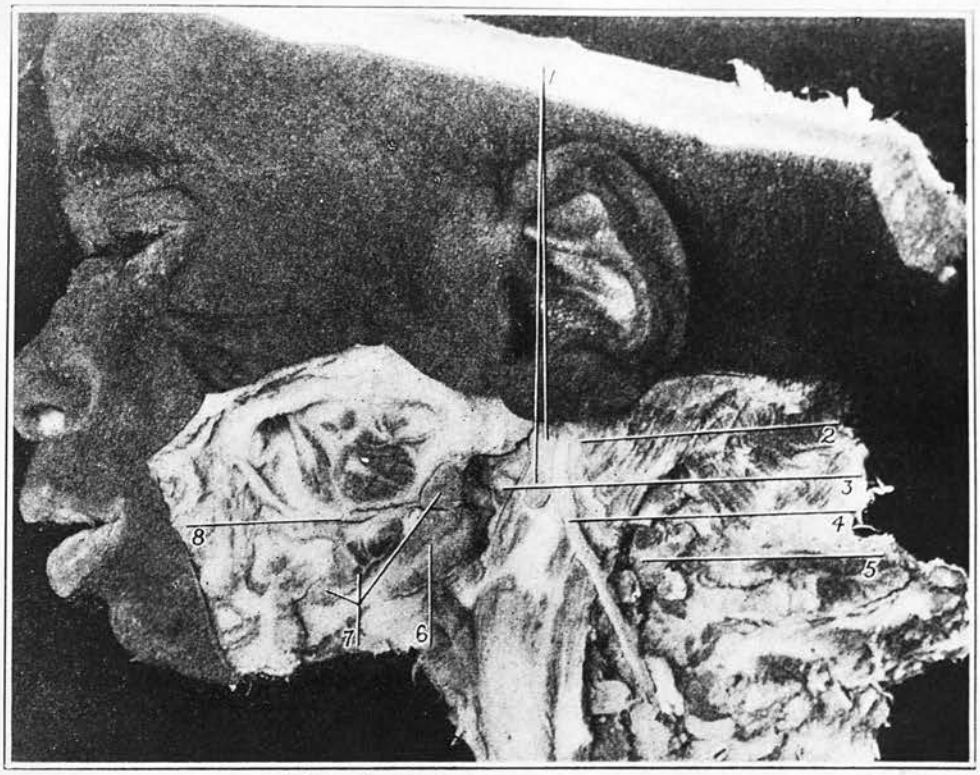
1. Facial nerve.
2. External carotid artery.
3. Stylo-hyoid muscle.
4. Facial artery.
5. Submaxillary lymph gland.
6. Hypoglossal nerve.
7. Posterior belly of digastric muscle.
8. Tonsillar lymph gland.

The efferent vessels from this group unite with glands from the Internal group, to form a common trunk, which terminates on the right side at the junction of the internal jugular and subclavian veins, while on the left, it joins the thoracic duct.

(b) INTERNAL GROUP (ANTERIOR): The upper division of this group is, perhaps, the most important series of all. The upper extremity of the chain rests on the posterior belly of the digastric muscle, and continues downwards, in intimate association with the internal jugular vein, usually towards its external aspect. Some of the glands in this group, have a fairly fixed position. Special reference may be made to a gland, situated below the posterior belly of the digastric muscle, at the junction of the thyro-facial and internal jugular veins, which is termed the TONSILLAR gland, owing to its important connections with the faucial tonsils, to be presently described. A few glands may also be found, between the internal jugular vein and the pre-vertebral vessels.

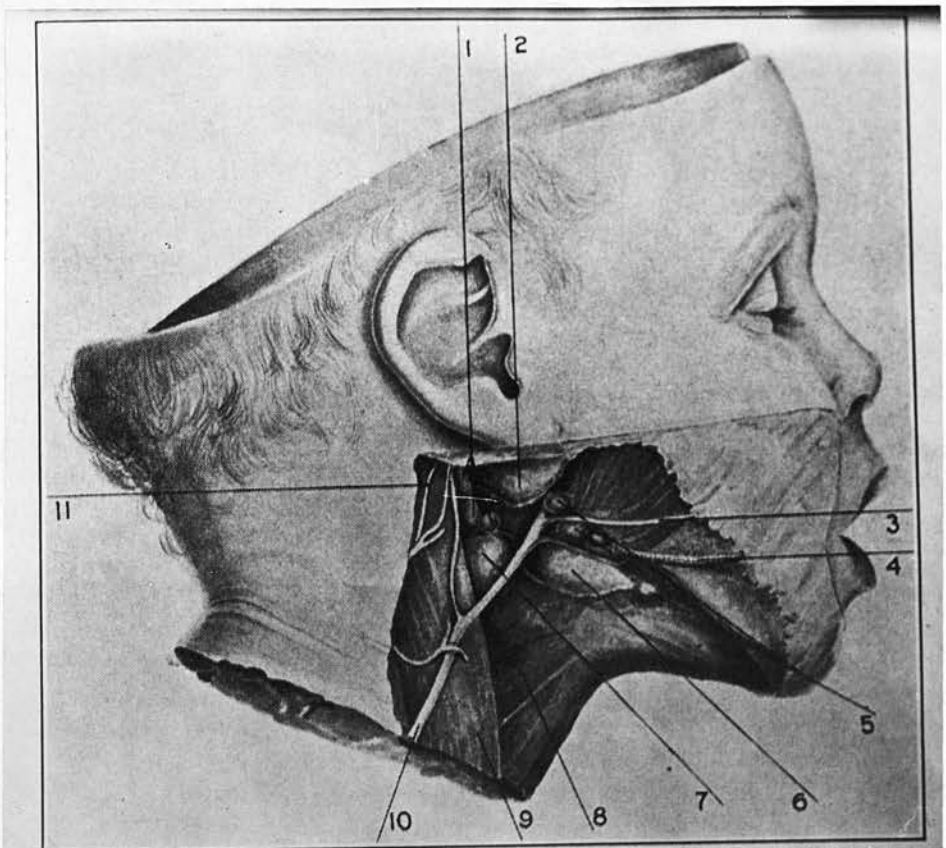
It was experimentally shown by WOOD (27) 20 years ago, that lymph vessels passed from the external portion of the tonsil, through the pharyngeal aponeurosis and superior constrictor of the pharynx, below the /

FIG. 3



(FROM G. B. WOOD)

1. External jugular lymph glands.
2. Great auricular nerve.
3. Tonsillar lymph gland.
4. External jugular vein.
5. External glands of sub-sterno-mastoid group.
6.& 7. Submaxillary salivary and lymph glands.
8. Facial artery.



Superficial dissection of Specimen No. II., showing portion of tonsillar lymph gland and its

(From G. B. WOOD)

1. Lymph Glands of the internal jugular group.
2. Parotid Gland.
3. Facial Vein.
4. Facial Artery.
5. Subaxillary lymph glands.
6. " salivary "
7. Tonsillar lymph gland.
8. Omohyoid muscle.
9. Sternomastoid muscle.
10. External jugular vein.

the facial artery, to pass posteriorly between the internal jugular vein and the stylo-hyoid muscle, to reach this specially placed gland, which can often be felt, just behind and below the angle of the lower jaw.

Absorption from the tonsils depends on two main factors, viz:-

(a) the action of the muscles of the throat during their physiological activities, which constricts the tonsils from time to time, and -

(b) the presence of lymph currents, directed towards the deep chain of cervical glands.

Efferent vessels pass from this gland, to those glands forming the chain below it.

This internal group of glands drains the following areas, in addition to the faucial tonsil, viz:- the parotid, submaxillary and submental glands, the majority of the lymphatics of the tongue, certain parts of the naso-pharynx, the whole of the middle and lower portions of the larynx, the palate, cervical portion of the oesophagus and the thyroid. It should also be noted, that there are many anastomosing branches between the internal and external group.

The efferent vessels go to form, with the bulk of the efferent vessels of the external group, the jugular trunk, which, as stated, on the right side joins the venous circulation, at the junction of the internal jugular and subclavian veins, while on the left side it usually ends in the terminal bend of the thoracic duct.

THORACIC LYMPHATIC GLANDULAR SYSTEM.

For the special study at present undertaken, it is necessary to give an anatomical resumé of the distribution of the lymphatics in the thorax, with special reference to the glands, in direct relation to the lungs and pleura. Later, certain anatomical aspects of the lungs and pleura, in relation to their lymphatic supply, will be discussed.

The Glandular Groups of the Thorax are usually divided into:

A. PARIETAL.

B. VISCERAL.

The Parietal Glands are sub-divided into:-

(1) DIAPHRAGMATIC GLANDS.

(2) RETRO-STERNAL GLANDS.

(3) INTERCOSTAL GLANDS.

(1) THE DIAPHRAGMATIC GLANDS are arbitrarily arranged in three groups, and their efferent vessels pass into the Retro-sternal glands in front, or posterior mediastinal glands behind.

(2) THE INTERNAL MAMMARY, or RETRO-STERNAL GLANDS, pass upwards in two delicate chains, one on either side of the sternum, in intimate association with the mammary arteries.

Their/

Their afferent vessels come from the anterior part of the diaphragm, upper part of the rectus abdominis muscle, anterior parts of the intercostal spaces, the skin of the praesternal region and the mammae.

The efferent vessels unite into a single trunk and pass into the venous system, usually at the junction of the internal jugular and subclavian veins, the exact point of entry varying somewhat.

(3) THE INTERCOSTAL GLANDS run in association with the blood vessels in the intercostal spaces, the posterior glands being more constant and important than the anterior glands.

The upper efferent vessels run towards the upper portion of the thoracic duct, where they terminate. The lower efferent vessels run downwards, to terminate in the commencement of the thoracic duct.

B. THE VISCERAL GROUP.

These glands are vastly important in relation to tuberculous infection.

They are sub-divided into three groups, viz:

(1) ANTERIOR MEDIASTINAL.

(2) PERITRACHEO-BRONCHIAL.

(3) POSTERIOR MEDIASTINAL.

(1) ANTERIOR MEDIASTINAL: The glands embraced by this group, are situated round the arch of the/

the aorta, stretching from the innominate vein on the right side, to the common carotid artery on the left side of the upper part of the thorax. Some authorities, e.g. BARITY,[29] consider these glands to be intra-thoracic prolongations of the deep cervical chain. POIRIER[26] does not agree with this view, as he says:-

"this mode of description does not represent the real facts". These anterior mediastinal chains are regarded by POIRIER[26] as ascending chains, whose efferent vessels empty into the venous system, about the same place as the deep descending cervical chain.

(2) PERITRACHEO-BRONCHIAL GLANDS: these glands were minutely described by BARITY[29] in 1874, and since then, no more detailed description has been attempted.

This important glandular group is sub-divided into four subsidiary groups, from the anatomical point of view, but it must be remembered, that they are all in intimate inter-communication, by means of small lymphatic vessels.

(a) RIGHT PRETRACHEO-BRONCHIAL group are placed in the angle formed by the trachea and the outer aspect of the right bronchus. Five or six glands, normally constitute this group, and are in relation to the inferior vena cava in front, and the right pneumogastric nerve behind. Externally, they are in contact with the/

the inner surface of the right lung, internally, with the trachea, while above, it reaches the subclavian artery and the recurrent laryngeal nerve, and below is in contact with the right branch of the pulmonary artery, and the termination of the vena azygos major.

(b) LEFT PRETRACHEO-BRONCHIAL group are smaller than the preceding, and are situated in the angle between the trachea and the outer aspect of the left bronchus, are in relation to the ascending portion of the arch of the aorta in front, and to the left pneumogastric nerve behind. Externally and internally the relations correspond to those of the right group, while above they are related to the arch of the aorta &the recurrent laryngeal nerve; below with the left bronchus and left pulmonary artery.

(c) THE INTERTRACHEO-BRONCHIAL group, as its name indicates, is placed below the bifurcation of the trachea, and consists of ten to twelve glands, being larger below the right bronchus than the left. They lie behind the pericardium, and in front of the oesophagus, the aorta and vena azygos major.

(d) THE INTER-BRONCHIAL GROUP occupy the angles of division of the larger bronchi. They are buried in the pulmonary parenchyma, and are in intimate association with the pulmonary artery.

(3) POSTERIOR MEDIASTINAL GLANDS: These glands are arranged round the oesophagus, chiefly on its anterior aspect.

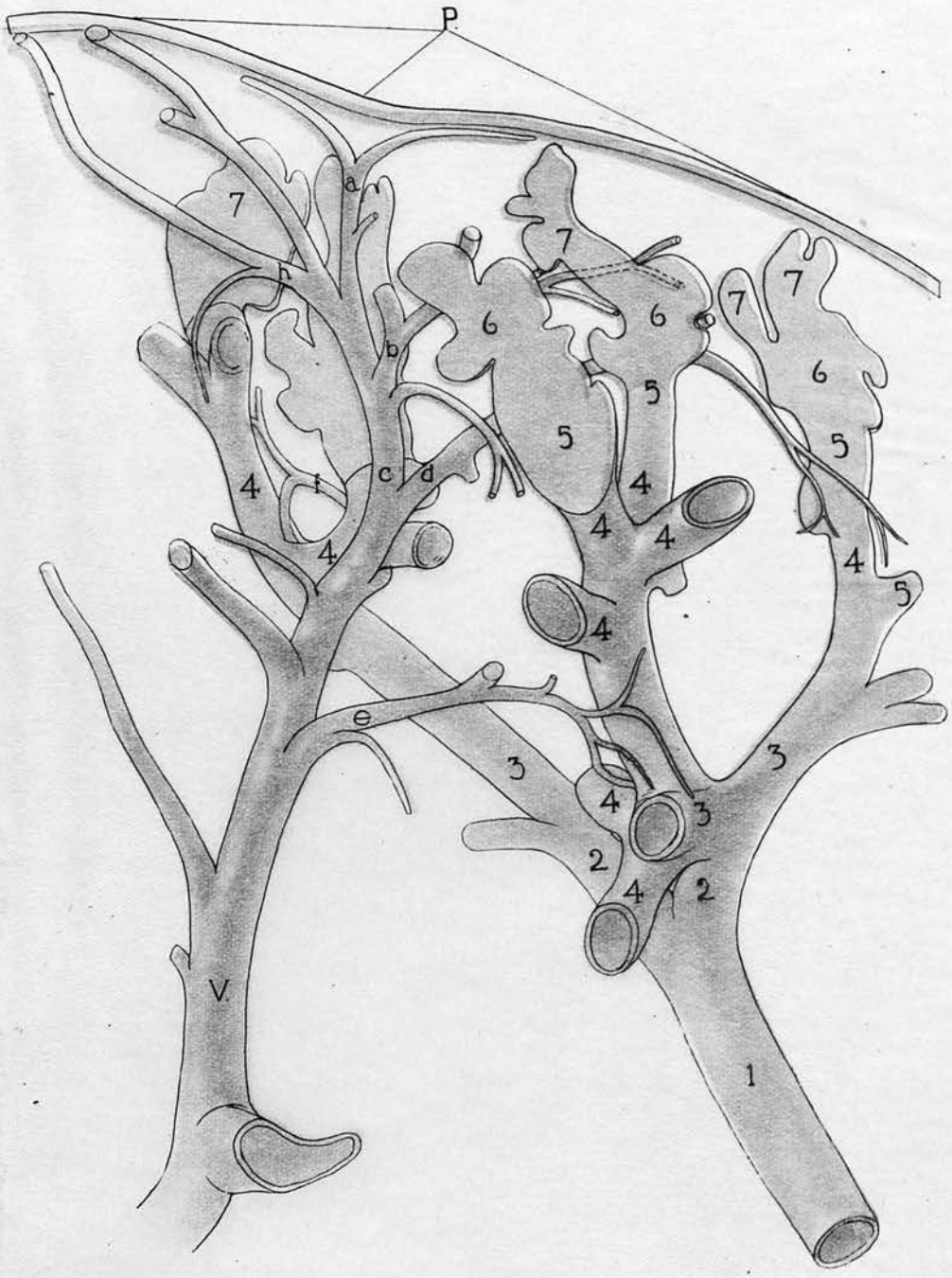
ANATOMY of the PLEURA and VESSELS of the LUNG.

It is necessary to recall the anatomy of the lung, with special reference to blood vessels and lymphatics, before considering certain aspects of tuberculous deposits therein. This subject has been studied extensively, by W. S. MILLER (30) by means of serial sections and reconstructions. He considers the older descriptions are now of little service. They were based on different methods of examination, and, he states, they did not take into account the last two divisions of the bronchial tree. The air spaces related to the last bronchial divisions are incorrectly described; the primary lobule (anatomical unit), and the secondary lobule, have been confused. He admits that finality has not yet been reached, but gives a more comprehensive picture than any other, the writer has so far come across.

PLEURA, BRONCHI, and AIR SPACES.

He first of all points out an essential anatomical difference between animals with a thick pleura, such as man and the ox, and those with a thin pleura, such as the cat, rabbit or guinea pig. The difference is, that in the "thick pleura" animals, septa dip into the /

FIG. 2. SCHEMATIC DIAGRAM OF THE AIR SPACES AND THE PULMONARY VEIN ABOUT THE TUBERCLE

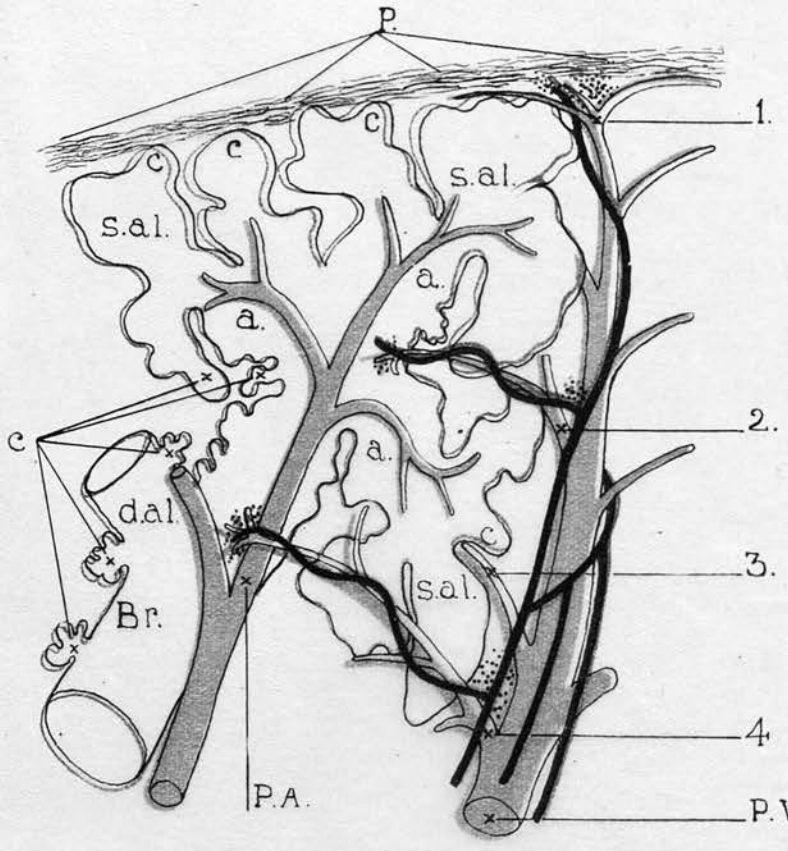


1 and *2*, different orders of bronchi; *3*, bronchiolus; *4*, bronchiolus respiratorius; *6*, ductulus alveolaris; *6*, atrium; *7*, sacculus alveolaris. *V*. Pulmonary vein with its branches *a*, *b*, *c*, *d*, *e*, *f*, *h*. *P*., pleura.

the lung substance from the pleura, forming pyramid-like lobules, with their base to the pleura, while in the "thin pleura" animals these septa do not exist. He, therefore, argues, that we must search for some fundamental unit, in both groups, which he terms the "anatomical unit". His conception of the "air spaces" is as follows:-

"If the main stem bronchus of a given lobe, or one of its branches, be followed towards its distal extremity, a point is finally reached, where the bronchioli into which it divides, no longer have a smooth tubular character, but there are opening out from their lumina in greater or less numbers, small air spaces, the alveoli, which correspond in size and structure to those which communicate with the ductuli alveolares, the atria, and the sacculi alveolares. Between these alveoli, and encircling the bronchioli, bands of smooth muscle are found, and the epithelium lining the bronchioli changes from a ciliated, columnar epithelium to a low cuboidal, non-ciliated epithelium; all traces of cartilage and mucus glands have disappeared. These divisions of the bronchial tree are known as the bronchioli respiratorii (respiratory bronchioles). Each bronchiolus respiratorius divides not always dichotomously, into ductuli alveolares (alveolar ducts): these are the last sub-divisions of the bronchial tree and it is from these sub-divisions/

FIG. 1. SCHEMATIC LONGITUDINAL SECTION OF A PRIMARY LOBULE (ANATOMICAL UNIT) OF THE LUNG SHOWING THE RELATION OF THE BLOOD VESSELS TO THE AIR SPACES AND TO THE PLEURA, THE POSITION OF LYMPHOID TISSUE AND ITS RELATION TO THE AIR SPACES, BLOOD VESSELS, LYMPHATICS AND PLEURA.



Br., a bronchiolus respiratorius which divides into two ductuli alveolares; *d. al.*, only one of which is carried out in detail; *a.a.a.*, three atria each of which communicate with sacculi alveolares; *s. al.*, around the periphery of which are situated the alveoli, *c.* Alveoli are also connected with the bronchiolus respiratorius, ductuli alveolares and atria. *P.*, pleura.

P. A., pulmonary artery which divides into three atrial branches and these in turn divide into branches which are distributed to the sacculi alveolares; from these latter branches the capillaries in the walls of the air spaces take their origin.

P. V., pulmonary vein which is made up of branches which arise: *1*, from the pleura; *2*, from the distal end of the ductuli alveolares; *3*, from the walls of the sacculi alveolares; *4*, from the neighborhood of the place where bronchi or bronchioli divide. The lymphatics of the veins are represented in black, and the position of the lymphoid tissue by the stippled areas. The bronchial artery and the lymphatics of the bronchial tree and of the pulmonary artery are not indicated.

sub-divisions that the parenchyma of the lung takes its origin. Each ductulus alveolaris has opening into its lumen a large number of alveoli and the amount of smooth muscle in its walls is less than that in the walls of a bronchiolus respiratorius. The distal end of a ductulus alveolaris is somewhat dilated; opening out from this dilatation, there are a variable number of irregularly spherical cavities, the atria. The smooth muscle in the wall of ductulus alveolaris has a sphincter-like arrangement about the openings, which suggests that by its contraction the muscle plays an important role in certain pulmonary affections; for example, in bronchial asthma. Each atrium communicates on the one hand, with a ductulus alveolaris, and on the other hand, with a variable number of larger and more irregular spaces, the <u>saculi alveolaris</u> (air sacs). Each sacculus alveolaris has opening into it a large number of much smaller spaces, the <u>alveoli</u> (air cells)". This will be understood by a glance at MILLER'S (30) diagrams, which have been taken from the article in question. This unit, with its blood vessels, lymphatics and nerves, can be demonstrated in both types of lungs. It may, therefore, be termed the primary lobule. The secondary lobules are the large areas in the "thick pleura" lungs enclosed in the connective tissue septa and contain from 50 to 250 primary lobules. The bronchus connected with these secondary lobules, enters at the apex of the pyramid.

BLOOD VESSELS.

THE BRONCHIAL ARTERY runs along the bronchi and divides with them. It forms a plexus and supplies both the outer and deeper bronchial tissues.

There is also an intra- and extra-bronchial venous plexus. Bronches arise from this, to form part of the beginning of the pulmonary veins. Venous radioles arising from the hilum and first and second division of the bronchi, form the bronchial vein, which opens into the azygos vein and intercostal veins.

The Bronchial Artery also supplies the lymph nodes, and forms vasa vasorum to the pulmonary vessels. It also sends branches to the septa, in the thick pleura animals, and supplies the pleura and network of blood vessels about the pleural lymphatics. The venous blood from these latter situations, enters the pulmonary veins.

THE PULMONARY ARTERY follows in its entire course, the sub-divisions of the bronchi, and the air spaces connected with them, taking a central place in the anatomical unit.

THE PULMONARY VEINS.

MILLER[30] says these veins may be traced from three sources of origin, and lie at the periphery of the unit, viz:-

(1) Pleural Capillary Network.

(2) Bronchial Wall Capillary Network.

(3) Pulmonary Artery Capillary Network.

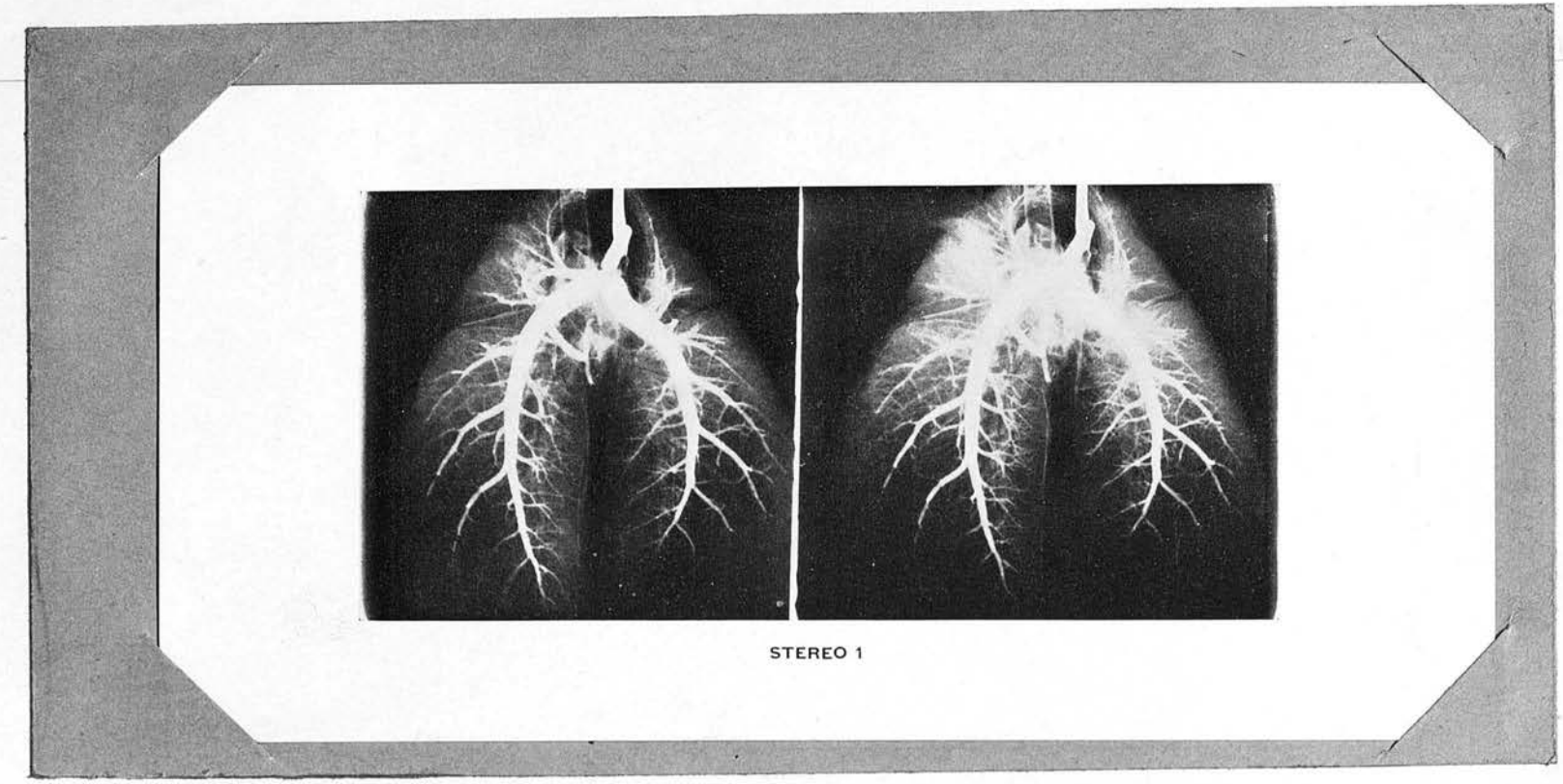
The majority of the pulmonary veins arise from capillaries formed by the junction of the pulmonary artery and vein; the former being central, and the latter being peripheral to the sacculi alveolaris. We may, therefore, speak of an arterial and venous side.

In "thin Pleura" animals, the capillary network is formed by branches of the pulmonary artery. In "thick pleura" animals, by the bronchial artery.

The capillary plexus formed by the bronchial artery, is drained by pulmonary veins; those coming from the ductuli alveolares are centrally placed in the anatomical unit - an exception to the usual rule.

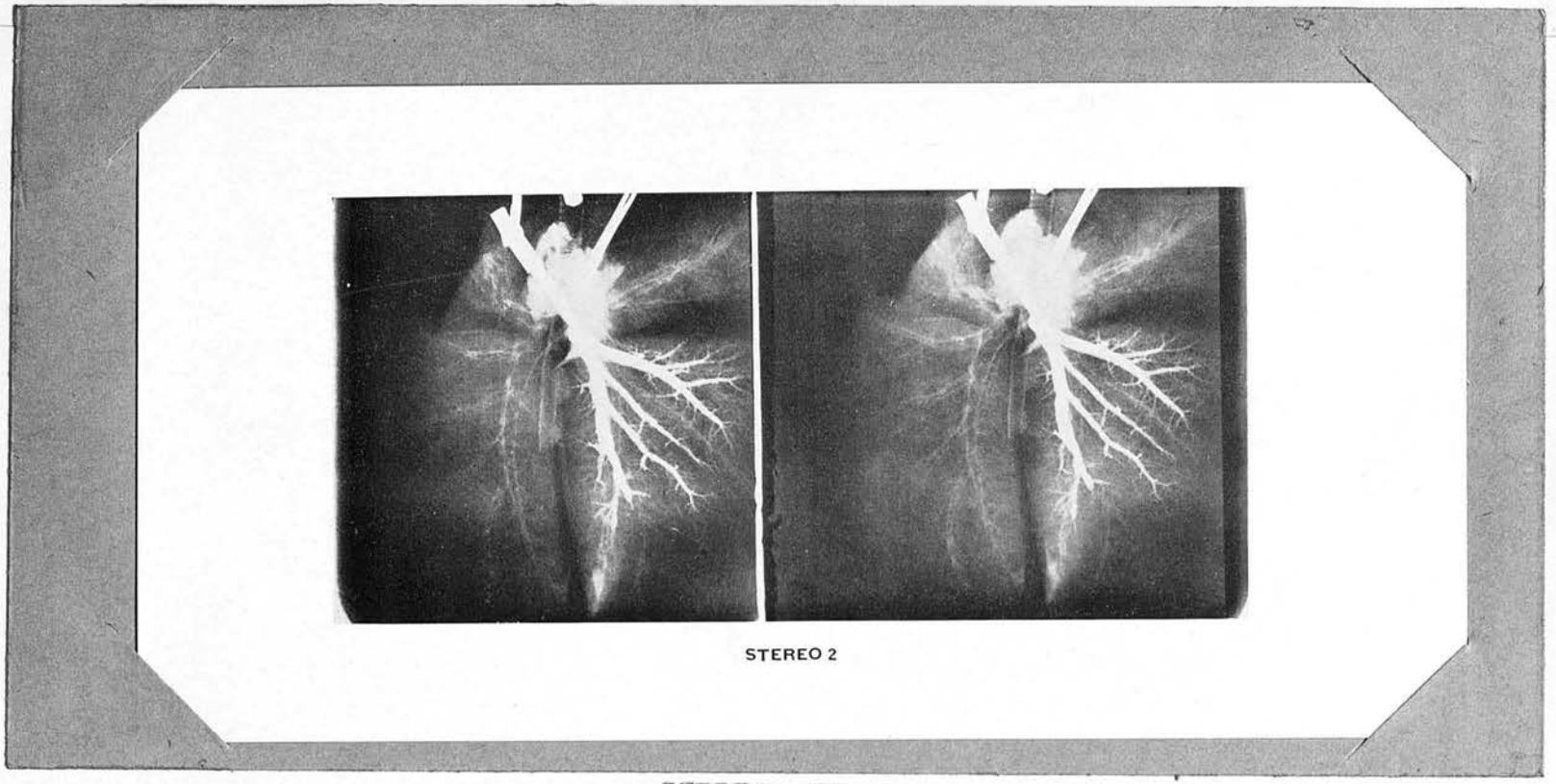
MILLER[30] describes the relationship of the larger branches of the pulmonary arteries, veins and bronchi thus:-

"The pulmonary artery follows in all of its subdivisions, the subdivisions of the bronchial tree. As each main branch of the pulmonary artery arches over its corresponding stem bronchus, it comes to occupy a position posterior (dorsal), and slightly lateral, to/



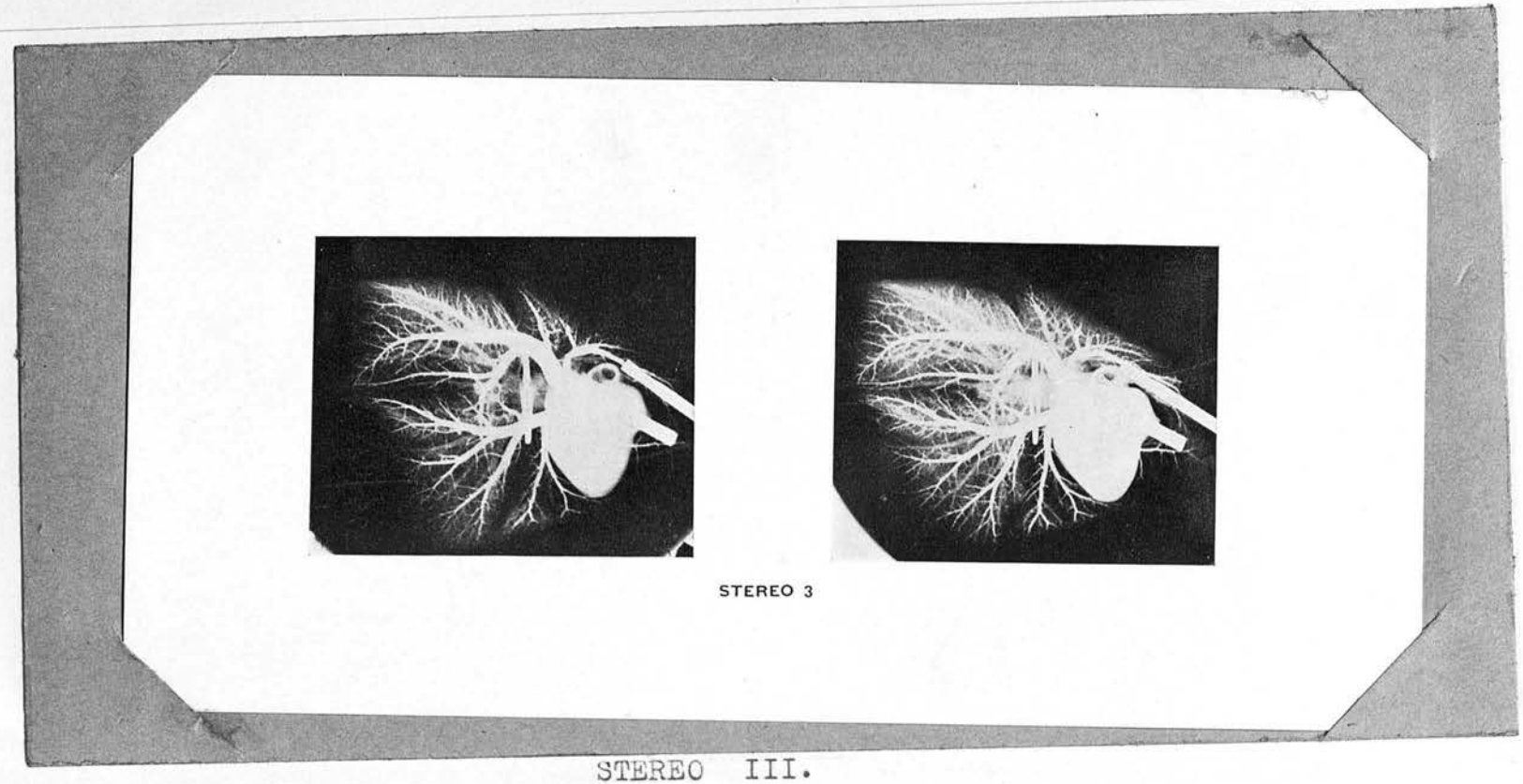
STEREO I.

Injection of Pulmonary Artery of a Pig. The main stem bronchi are faintly seen lying mesial to the main artery. They join and form the trachea seen in the upper part of the photograph. Mesial to the bronchial tubes will be seen a faint shadow, constituting the pulmonary vein. The injected and distended arteries are in closer apposition to the bronchi than are the veins.



STEREO II.

Lung of Pig with the pulmonary vein of the left inferior lobe, partially injected and distended with air. The pulmonary vein can be seen anterior and mesial to the main stem bronchus. The pulmonary artery not being injected, cannot be made out clearly, but MILLER points out, that the lateral wall of the stem bronchus is denser than the mesial. This increased density is due to the close proximity of the pulmonary artery.



STEREO III.

Lung of a Dog, in which the pulmonary artery was injected with a vermilion starch mass, showing as a uniform dense shadow; and the pulmonary vein was injected with an ultramarine blue starch mass, showing up as a less dense and finely granular shadow. The lung is rotated slightly to the right, and the heart is displaced forward, in order that the main blood vessels may be more closely seen. The left pulmonary artery is, therefore, in a prominent position in the upper part of the stereo.

to the bronchus. The relation of the main trunks of the pulmonary vein to the bronchi is quite different; they are situated anterior (ventral) and mesial to their stem bronchi, and in their ultimate distribution are situated as far removed from the bronchi as possible. I lay emphasis on "as possible", for in some situations they are found near the bronchi, but never as closely associated with it as is the 'artery'." These points are made clearer by a study of the three stereo-photos taken from MILLER'S (30) article.

THE LYMPHATICS.

THE BRONCHIAL LYMPHATICS form a rich network which accompanies the entire bronchial tree, but no lymphatics are present in the air spaces distal to the ductuli alveolares. In the ductuli alveolares, the lymphatic network has been reduced to three small vessels.

THE PULMONARY ARTERY LYMPHATICS run in intimate connection with both arteries and bronchi. CUNNINGHAM (31) has pointed out the developmental association of the bronchial and arterial lymphatics from one plexus.

PULMONARY/

PULMONARY VEIN LYMPHATICS.

It has been noted that the bronchial lymphatics end in three small vessels, when they reach the ductuli alveolares - one small duct joins the network about the pulmonary artery, the other two pass to join small veins which arise in this area. Lymphatics also pass from the bronchial network to the veins.

Lymphatics also accompany pulmonary veins arising from the pleural surface. In the septa of the secondary lobes, the lymphatic network is rich, and accompanies the veins in this area. COUNCILMAN (32) first described this region in relation to the lymphatics, and it will be again referred to, in relation to the flow of lymph.

THE LYMPHATICS of the PLEURA are arranged as an extensive network, with loops dipping into the lung, but not giving off pulmonary branches - the loops always coming to the pleural surface again. There are, however, certain lymphatics which do connect the lung proper with the pleura, and have considerable significance in relation to the lymphatic flow. These will be referred to presently.

LYMPHOID TISSUE of the LUNG.

Lymph nodes are situated at the bronchial bifurcations, but seldom beyond the third division of the bronchial/

bronchial tree. MILLER (30) points out other locations where lymphoid tissue may be found, viz:-

(1) Bifurcation of bronchi and bronchioli.

(2) Distal ends of ductuli alveolares.

(3) Along the course of the pulmonary artery

(4) Where veins arising from the bronchial tree meet larger veins.

Lymphoid tissue is always situated outside the muscular layer of the bronchi. In the pleura, lymphoid tissue is to be found, where the venous radioles of the pulmonary vein unite with their venous trunk, and the lymphatics which accompany the venous trunks, join the pleural network of lymphatics. This arrangement is specially seen in the connective tissue septa of "thick pleura" animals. Increase of age and pigment, tends to increase this lymphoid tissue in the human lung.

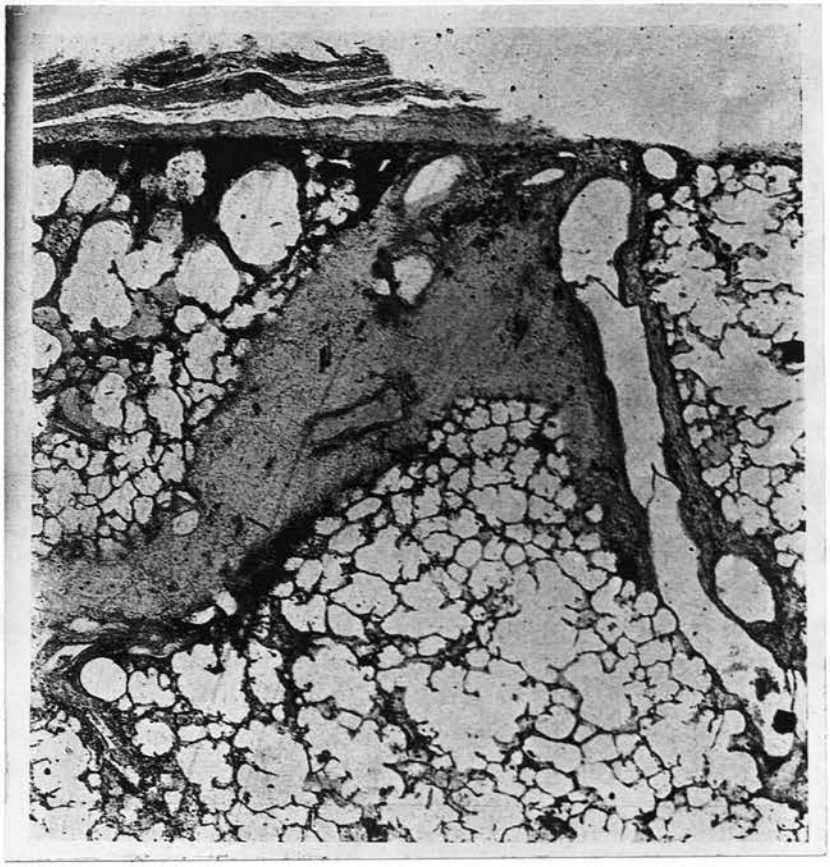
THE DIRECTION of the PULMONARY LYMPH FLOW.

Considerable diversity of opinion exists on this point, but in view of W. S. MILLER'S (30) researches on pulmonary lymphatic anatomy, both in man and animals, he has felt justified in formulating certain statements, in relation to the flow of lymph. He realises the importance of this question to the clinician/

clinician, and it is more than probable, that certain clinical phenomena rest on certain anatomical facts, relative to the pulmonary lymphatic system. He lays considerable stress on the presence of valves at certain points in the lymphatic system, more particularly referring to the direction in which they point. He says:-

> "Valves permit the flow, be it lymph or blood, in only one direction . . . . . the true function of valves, as expounded by HARVEY,(33) remains unshaken".

The pulmonary lymphatics have a "plexus" type of origin, and in the early stages of development no valves are present. Later valves develop in the pleural network, and at the junction of the deep lymphatics with the pleural group. No valves have been found in the lymphatics, which run in conjunction with the smaller divisions of the bronchial tree, arteries or veins, but in some instances, valves have been found in main trunk lymphatics, accompanying the bronchi, and in the lymphatic trunks about the pulmonary veins near the hilus. The lymphatic valves in the pleural network, point in all directions, but in this group, there is such free communication that the flow is not always in the same direction. In the main trunks, however, which drain this plexus, all the valves/



(FROM W.S.MILLER)

The photo includes a thickened septum at the point where three lobules meet. The pleura was thickened and adherent, and part of the pleura was torn off in the removal of the lung. A widely dilated lymphatic vessel is seen to the right of the photograph with valves pointing towards the pleura.

valves point to the hilar glands. The valves situated on the deep lymphatics draining to the pleura, all point to the visceral pleura. Valves found on the main intra-pulmonary lymphatic trunks, point to the hilus. Considerable importance is attached to the short valve containing lymphatic vessels which drain to the pleural surface. These vessels are more clearly seen in pathological lungs than in the normal, because the interlobular septa become thickened and notched on the surface. This is specially so, at the points where the pulmonary veins from the pleura pass to these septa. This particular septal vein is accompanied by a lymphatic vessel, and it is this particular vessel which shows the valves pointing to the pleura. Normally lymphatic drainage within the lung, is towards the hilus, but these vessels may be obstructed pathologically, and the flow of lymph may then take place in a retrograde way to the pleural group of vessels as the valve points in this direction. Further, the presence of these valves prevents lymphatic flow from the pleura to the deeper pulmonary tissues. No lymphatics, unconnected with lymph nodes, have been seen leaving the lung. Drainage from the hilar glands, is into the thoracic duct.

This anatomical arrangement of lymphatics and position of the valves, may, in a great measure, explain/

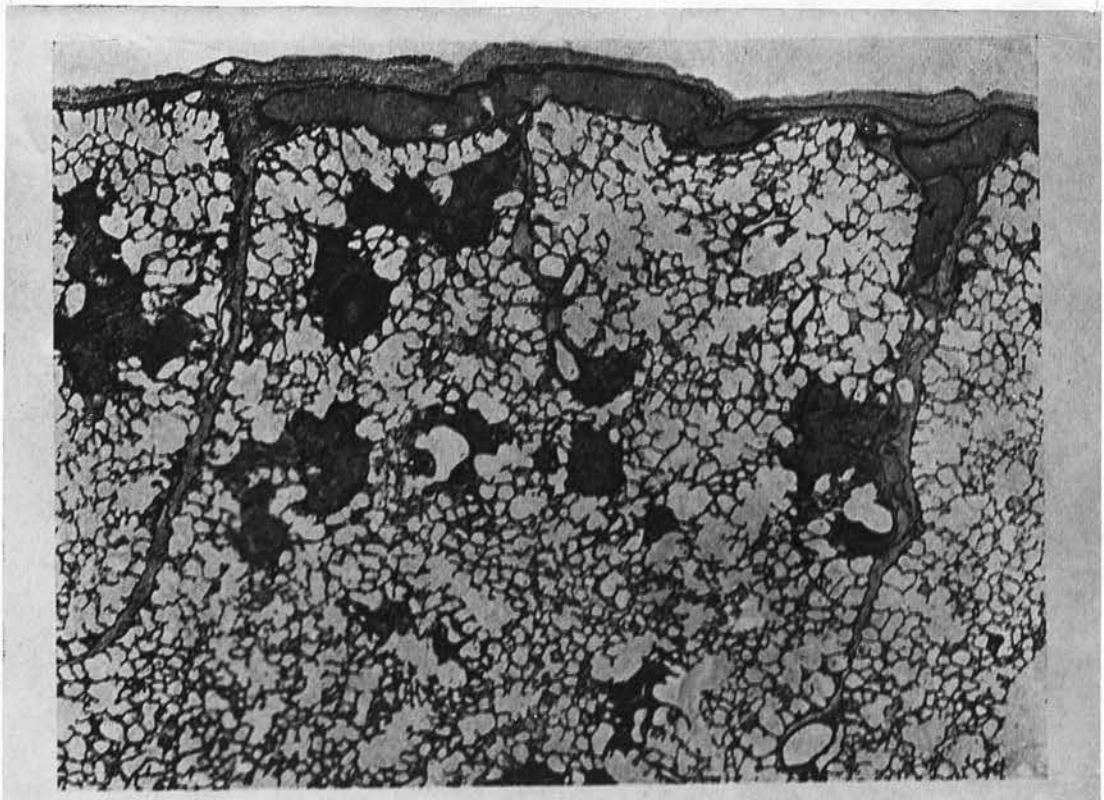


Fig. 5.* Photograph of a Section of a Human Lung Taken Perpendicular to t

PHOTOGRAPH of a SECTION of a HUMAN LUNG taken perpendicular to the PLEURA, through a Secondary Lobule. (From W. S. MILLER).

A tuberculous mass is seen projecting into the septum on the right and compressing the lymphatics. Between this point and the pleura, the lymphatics are widely dilated, while below this point, the septum and lymphatics are of normal size. Near the centre of the section is seen a secondary septum, hanging at right angles to the pleura. This small septum marks the boundary between two anatomical units. To the left of this small septum is a conglomerate tubercle which is encroaching on the septum, but the lymphatic vessel is dilated deep to this tubercle, and drainage is taking place normally to the hilus.

explain certain, well accepted, clinical facts, in relation to tuberculous pulmonary disease. For example, a sharp pleurisy may be the only clinical manifestation of pulmonary tuberculosis. It is, also, a well known fact, that pleural infections are often easily curable, and do not spread to give rise to intra-pulmonary disease. It is also a common clinical experience, that intra-pulmonary disease may develop without symptoms of pleurisy, but at a later date "Exacerbations" of a pleuritic nature may take place, due probably to infection spreading backwards to the pleural plexus, because of the obstruction of the intra-pulmonary lymphatics. It is, also, more than likely, that this valvular mechanism has a definite bearing on the old view of retrograde lymph flow.

From a discussion of these anatomical and physiological facts, it can be said, that no lymphatics have been seen in walls of the air spaces beyond the ducti alveolares, that the pleural and intra-pulmonary lymphatics are more or less distinct entities, which, however, have two important points of junction, viz:- the pleura, and the glands at the hilus of the lung. This naturally leads to the obvious conclusion that the glands situated round the root of the lung receive all the lymphatic trunks from the lung and its/

its immediate covering, and, therefore, any form of pulmonary infection,be it pleural or intra-pulmonary, will sooner or later cause some pathological disturbance of the glands at the root of the lung. This fact is so well known, that the term hilus tuberculosis is now frequently employed. It is, perhaps, an unfortunate term, for it tends to focus the mind on one particular group of glands to the exclusion of others, but, if the fact be kept in mind, that evidence of tuberculosis in this group of glands is usually part of a general lymphatic infection, a correct perspective will be maintained.

Scope/

SCOPE of the INVESTIGATIONS.

The observations embodied in this Thesis constitute an endeavour to estimate several points, with reference to Tuberculous infection, amongst a small group of school children, and to co-relate this state of infection with other phenomena discovered during a minute physical examination.

The frequency of Tuberculous infection, by the time a child reaches school age, as has been already stated, is a fact beyond dispute. The significance of this fact, however, is hardly yet fully appreciated. It is, most certainly, not appreciated by the parents of the children, for it is one's frequent experience, that when the fact of infection is pointed out to individual parents, consternation reigns, and they totally fail to grasp the significance of the information. Frequently, in fact, they interpret a simple statement as to the presence of infection, as meaning that the child is suffering from tuberculous disease. The public are still in much need of further education as regards the significance of this fact. Medical men do not fully appreciate the vast importance of seeking out tuberculous infection amongst children.

Several methods of carrying out such an investigation suggested themselves, e.g. application to the School Board Authorities for permission to examine/

examine day scholars, application to the proprietors of a private school, or application to the governors of an industrial boarding school - each of these lines had advantages and disadvantages.

I. A group of Day Scholars, attending a Board School, would give a good sample of the Edinburgh Industrial population at school age, but the difficulties in carrying this through were seversl, viz:-

(a) It would necessitate interruption of lessons.

(b) There would be obvious difficulty in having radiograms taken.

(c) The parents might easily raise objections, as suspicions of experiment are at present very prevalent in the Industrial lay mind.

(d) Considerable variations in home conditions, and lack of discipline.

II. Application to the proprietors of a private school, was not considered seriously, as it was thought certain that parents would have objected to this investigation as a form of experiment, involving their children in a rather tedious procedure. The writer had an experience on these lines once, when investigating the blood of children suffering from Whooping cough at a Boarding School, some years ago. The children wrote home telling about the withdrawal of drops of blood, and several parents wrote to the Head Master, asking why this was being done.

III./

III. It was, therefore, decided to make application to the Governors of an Industrial Boarding School in Edinburgh, to carry out this investigation. The writer was fortunate enough to receive the permission of the Governors, and he wishes here to record his indebtedness to Dr. D.J.Graham, who 'backed' his request to the Governors. Without Dr.Graham's backing, it is doubtful if the request would have been granted.

The School consisted of over 200 pupils - boys and girls - of which about half were deaf mutes. The House Governor selected the 'hearing' boys, as a suitable group for investigation. It was, obviously, useless to attempt to examine the deaf-mutes, as a certain amount of intelligent co-operation was required on the part of the boys. The writer explained fully to the House Governor, exactly what he wanted, and he was granted every facility in carrying out his investigations. Without his generous co-operation, the results obtained could not possibly have been realised.

It may be as well to indicate the advantages and possible disadvantages, of selecting a group of boys, such as were obtainable at this school.

ADVANTAGES/

ADVANTAGES:-

(1) The boys belonged to the industrial class.

(2) They gained admission to this school owing to straitened circumstances at home. In almost every instance one or other parent was dead, or severely afflicted with deaf mutism.

(3) They varied in age from 5 years to 14 years - the industrial school age.

(4) They were well disciplined, well housed, well fed and well educated, both from the mental and physical point of view.

(5) Examinations could be conducted without interrupting school lessons, the writer being notified when a certain group of boys were available.

(6) They could be sent for X-ray in groups of four, in the evening after school hours.

(7) The boys were all 'fit' in that they were capable of attending school regularly and taking part in the normal physical activities of the school.

(8) They were all under careful, medical supervision, special care being taken of the teeth and throats. This fact became obvious as the examination proceeded.

DISADVANTAGES/

DISADVANTAGES:-

(1) The numbers were small viz:- sixty.

(2) The homes of the boys were scattered throughout Scotland, although most of them came from Edinburgh and Leith.

(3) The family history and history of previous illnesses was entirely lacking, except for one or two isolated facts, in one or two of the boys.

(4) In carrying out the PIRQUET test, certain objections were raised, until it was explained what exactly was entailed, but 'repeats' could not be carried out.

TO SUMMARISE:- The writer had access to a group of Industrial Schoolboys in a boarding school, where they were under perfect discipline, sound medical supervision and easily handled. The numbers were certainly small, but it allowed ample time for a thorough, physical examination.

PROCEDURE.

This entailed:-

(1) Vital Capacity Readings.

(2) A PIRQUET Skin Tuberculin Test.

(3) Careful physical examination.

(4) Radiogram of the Thorax.

These/

These several observations were all carried on at separate times, so that no question of Auto-suggestion might arise in co-relating the findings. In fact, a long time elapsed after the examinations were completed, before any attempt at co-ordinated analysis was carried out. In this way it was hoped, as far as possible, to keep separate the facts gained from the various examinations, and prevent any tendency to sway the ideas of the writer to one or other view. When one examiner is conducting all the investigations, there is a natural tendency to group facts into certain classifications, as the work proceeds. A strenuous endeavour has been made in this series of observations, to prevent any such fallacy. It is possible that one may have gone too far in this matter, but the intention was, as far as possible, to make the several observations independently, and co-relate the findings without bias.

In/

In the clinical description of the cases, (See Vol.II.) the vital capacity readings are set out early. The reading of each boy is given, and DREYER'S (34) figures for each individual measurement of Height, Weight, and stem length are given for comparison. To maintain a correct sequence, it seems best to review, at this point, certain facts as to -

VITAL CAPACITY.

The serious study of vital capacity probably began with JOHN HUTCHINSON'S (35) discovery of the Spirometer in 1846. He used rather a cumbersome instrument, but it accurately measured expired air. He tested about 2,000 individuals of various occupational and social grades. His standards were used for many decades. No further serious study of the question appeared, till 1917, when PEABODY & WENTWORTH (36) carried out studies by means of a wet spirometer, made by the Sanborn Coy., on 140 normal adults, grouped as to sex and standing height. They also made observations by comparing their readings with the surface area of the individual. Their standards and observations have been extensively quoted in subsequent articles on this subject. The European War stimulated more work on this subject, because of the urgent necessity/

necessity for physical fitness for service, and super-fitness for certain branches of the Imperial Forces, e.g. The Royal Air Force. In Britain, DREYER[34] of Oxford, studied the question of vital capacity extensively, and prepared a long series of tables, based on mathematical formulae, giving the relationship between body weight, chest measurement and "stem length" in relation to vital capacity readings. This greatly reduced the work of estimating the percentage of vital capacity possessed by an individual, in relationship to their respective measurements. DREYER[34] applied his mathematical formulae to 959 Oxford undergraduates, studied by SCHUSTER[37] and found the results very satisfactory. Many other investigations on vital capacity in adults, were made by other observers. For example, LUNDSGAARD & NANSLYKE[38] studied the relation between thoracic size and lung volume, in normal adults. WEST[39], J.M. MEYERS[40], HEWLETT & JACKSON[41], SHEPHARD & MEYERS[42], all published studies of vital capacity, in relation to body measurements and surface areas. ROGERS[20], compared standing height and stem length with vital capacity readings, in 400 male University students, between 18-30 years of age. He found that the co-efficient of co-relation between stem height and vital capacity/

capacity, and that of standing height and vital capacity, were approximately equal, viz:- 0.47 and 0.46 respectively. Articles have also appeared, showing the relation between pathological lesions and vital capacity. SHEPHARD (43), published a paper on the effect of certain past diseases on vital capacity. LEMON & MOERSCH (44), also published a paper on factors influencing vital capacity. FOXTER & HSIEU (45) on the vital capacity of the Chinese. They divided them into eleven occupational groups, and found, that occupations affected the vital capacity to some extent, but not in proportion to physical activity. They also found, that Chinese show a much lower ratio than Western races, which strongly suggests a racial factor. PRATT (46), on health and heart disease, in relation to vital capacity. MEYERS & CANDY (47), studied the effects of senility on pulmonary vital capacity. The most recent article is, probably, that published by SHEPHARD & MEYERS (42), where they made a comparative study of vital capacity standards, in 3,534 male university students. They came to the following conclusions:-

1. When applied to 1,641 carefully selected male university students, the commonly used standards for estimating vital capacity from surface/

surface area, height and weight practically coincide.

2. The estimate based on chest circumference gives readings considerably lower, while sitting height (stem-length) is too high.
3. When applied to this selected group, all standards give too high readings for a normal distribution.
4. Great care should be exercised in selecting normals for purposes of working on standards.

Fewer investigations of vital capacity have been undertaken in children for obvious reasons. When the investigation of the children, reported in this thesis, was begun, the writer was unaware of any paper dealing with the subject, specially in relation to its use as a possible test for tuberculous infection or disease. He was, of course, aware of DREYER'S tables, which obviously covered school age, but there is no report in DREYER'S book to say that his figures were based on actual measurements. They are regarded rather as the result of mathematical formulae, used to work out from given standards, what the ratio should be for various groups. Since then, however, several articles have been discovered, or published at a later date, dealing with vital capacity in children, some of them touching on the question of Tuberculosis./

Tuberculosis. EMERSON & GREEN (48), examined 350 children, taken from Boston Childrens' Hospital out-patient department, the Floating Hospital, a boys' club, orphan asylum and two settlement houses. The boys were grouped in four sections, according to their height - 6 inch limits marking off the groups, thus:-

GROUP	AVERAGE V.C. in LITRES.	SURFACE AREA in SQUARE METRES.	RATIO V.C. to SURFACE AREA.
	A	B	A ÷ B.
1. (Tallest)	1.8	1.5	1.2
2.	1.4	1.3	1.1
3.	1.1	1.1	1.0
4.	.8	1.0	.8

Previous to grouping the boys, a physical examination was made, to eliminate any sufferers from Pulmonary or Heart Disease.

They, therefore, conclude, -

(1) There is a very close relationship between vital capacity and surface area in children.

(2) There is practically no difference between children considered in these tables for normal weights for heights and those falling 7.5% below the normal.

(3) Vital capacity determinations below seven years of age, are of little value.

EDWARDS/

EDWARDS & WILSON (49), studied 360 normal children between the ages of 6 and 16, to estimate the question of variability, when spirometers of different types were employed, and the relation of vital capacity to various body measurements. Certain spirometers gave persistently low readings, due to lack of delicacy, when dealing with children. They consider that the weight unit gives greater accuracy than any other measurement, as the chance of error is less. The vital capacity per unit of surface area, showed gradually increasing values from the smaller to the bigger children. They also concluded that the vital capacity values obtained from children, showed a degree of variation, equal to that exhibited by other fairly comparable physiological variables. They estimated the co-efficient of variation at 14.2%.

WILSON & EDWARDS (49), realising that a good deal of work had been done on vital capacity, in relation to valvular disease of the heart, studied a group of children which showed no valvular lesion, but had a definite predisposing history of Rheumatism, Chorea, etc., and a normal exercise tolerance. They termed this group, cases of "Potential Heart Disease". They compared these cases with a normal group, and in both/

both sections, found cases with a low vital capacity reading. This raised in their minds the question of some other pathological lesion, such as tracheo-bronchial tuberculous adenopathy.

WILSON, EDWARDS & LISS[49a], followed up their previous observations of vital capacity in children, very much on the lines adopted by the writer when he began his work. So far as one can find, in English or American literature, these observations are the first published results on the co-relation between vital capacity readings and X-ray findings. These authors regard the investigation of vital capacity as of considerable importance in the diagnosis of tracheo-bronchial adenopathy. They refer to the difficulty in diagnosing tracheo-bronchial adenopathy in children, and mention the views of certain authorities, showing considerable variations in interpretations of physical signs, relative to this subject. Reference is also made to the difficulty of interpreting radiograms of the chest, although they admit that:-

> "there seems to be a general agreement that an increase in the hilum shadow, is indicative of engorgement and enlargement of the intra-thoracic glands, and that the accompanying extensive linear markings, radiating to the lung periphery, particularly to the upper parts of the lung, may be considered pathologic".

Two/

Two groups of children were selected.

GROUP I. (83-50 white,33 coloured) included children between 5 and 12 years of age, clinically healthy, who passed a routine physical examination.

GROUP II. (30) included children with symptoms and physical signs suggesting tracheo-bronchial adenopathy.

GROUP I. was complicated by a sub-division into : -

(a) white, and

(b) coloured children.

The X-ray findings were divided into three classes, depending on the extent of the shadow from the hilus, and were termed +1, +2, +3, with reference to this shadow. It was found that all cases, classed as +3, showed considerable reduction of vital capacity amounting to an average of 23% - the highest being 42%. Those cases, classed as +1 and +2 fell within the normal limits for vital capacity readings.

They found that 16% of apparently normal white subjects showed diminished vital capacity, and roentgenological evidence of tracheo-bronchial adenopathy, while 84% of the coloured children showed the same. They suggest that any apparently normal child who shows a diminution of 15% vital capacity, should have/

have a radiogram taken. The authors are so impressed with the close co-relation between vital capacity readings and X-ray findings, that it may be predicted that children revealing a normal, vital capacity reading, will give a satisfactory radiogram, and that a reduction of 15% or more in the vital capacity, in the absence of other factors known to diminish vital capacity, will give a radiogram, indicative of tracheobronchial adenopathy.

VITAL CAPACITY READINGS.

DETAILS of PROCEDURE in the PRESENT INVESTIGATION.

The term "vital capacity" in this series of observations, is used to denote the maximum amount of air expelled from the lungs, after taking the fullest possible inspiration. The air is expelled entirely by voluntary effort, no pressure of any kind being made on the abdomen. The wet spirometer, made by the Sanborn Company, and of the same type used by PEABODY & WENTWORTH (36), was the one selected. It consists of a nickel plated tank, above which is a cross bar, on which is fixed a wheel with a recording scale marked on it. A copper cylinder is fixed inside this tank, with an aperture at the lower end, into which air is blown from the lungs through a mouthpiece and tube. At the upper extremity, there is another circular/

circular opening, centrally situated. Water is now poured round this central cylinder, and over the cylinder is placed a thin copper jacket, which dips deeply into the water, and when not in use, rests on the top of the inner cylinder. This outer jacket has a thin cord attached to its central point. This cord passes through the cross bar, over the scale wheel, and is fixed to an elongated weight, which runs in a specially made tube. This outer cylinder and weight are finely balanced, so that the slightest increase of air, in the central air containing cylinder, will cause the water jacket to rise and register the amount of air passed in, by the movement of a pointer on the recording scale. The whole apparatus is well made and well balanced, to reduce friction errors to a minimum.

Each boy was seated easily, with his feet on the floor in front of the instrument and instructed to draw in as deep a breath as possible, place the mouthpiece firmly in his mouth, and blow vigorously into the instrument. Care was taken that no air escaped by the nose. Several boys were always in the examination room, at the same time, and an atmosphere of completion was engendered. The result of three attempts was recorded, and the highest figure was taken as the reading/

reading for the vital capacity of each boy. If there was any evidence of faulty technique on the part of the boy being tested, that particular effort was not recorded. The scale was marked in litres and one tenth of a litre. The figure read was taken as so many litres and two decimal places beyond, i.e. down to one hundredth of a litre.

It was quite impossible to estimate down to individual ccs. and, therefore, the four figures appearing in DREYER'S tables are, perhaps, hardly comparable with those here reported, but the writer cannot see that anything under 10 ccs. is of much significance or of any importance. If this were to be obtained, then a different kind of spirometer and scale would have had to be employed, and it was not available. In estimating the percentage gain or loss in vital capacity, it was found that the increasing of DREYER'S figure made such a slight difference as to be negligible for practical purposes.

THE PIRQUET SKIN TEST.

The records of these findings follows next in sequence in the clinical reports.

Since the introduction of the tuberculin skin test by VON PIRQUET (50), in 1907, much work has been done on the subject of investigating the frequency of tuberculous infection at all ages, more particularly in children. Many other forms of tuberculin tests have been used, but reference need only be made to the PIRQUET test here, as that was the only one applied to the children investigated in this series of observations.

Perhaps the most frequently quoted results are those of HAMBURGER & MONTI (51), which are typical examples, illustrative of the fact that as age advances, there is an increased frequency of positive results, till the age of adolescence is reached, after which few persons living an urban life escape infection.

HAMBURGER & MONTI (51), give the following results:-

In a series of 509 patients in Hospital for diphtheria, scarlet fever and other infectious diseases, except measles, tested cutaneously, and if doubtful subcutaneously, gave 271 or about 53%. Divided into age/

age groups we have:-

2nd Year of Life	- 9%	Positive.
3rd to 4th " "	" - 27%	"
5th to 6th " "	" - 51%	"
7th to 10th "	" - 71%	"
11th " 14th "	" - 94%	"

Many considered these results to give a false inpression as to the frequency of infection, as the children tested were all hospital cases and, therefore, debilitated, and from the poor classes, who have more chance of picking up infection than the well to do classes. A few statistics from other quarters and grades of society may, therefore, be given.

S. A. SLATER (52) carried out the PIRQUET test on 1,654 children in a rural district of Minnesota. The parents of the children tested, belonged to a wealthy farming section of the population, where the death rate from Tuberculosis was only 35 per 100,000 of the population. School children only, were used and 'old tuberculin' was the type employed. The usual skin reaction was carried out, with a control, and the reaction examined 48 hours later. He tested several of the 'negative reactors' a second time, but found the results co-incided.

TABLE/

AGE	No HISTORY of EXPOSURE.		HISTORY of doubtful EXPOSURE.		HISTORY of known* EXPOSURE.		TOTAL +	-	% +
	+	-	+	-	+	-			
5 & under 1		39	6	44	5	5	100	12 88	12%
6	3	34	6	82	4	1	130	13 117	10%
7	1	42	7	106	2	1	159	10 149	6%
8	2	41	9	93	4	1	150	15 135	10%
9	4	47	7	92	7	0	157	18 139	11%
10	0	58	15	103	6	1	183	21 162	11%
11	3	60	8	82	4	0	157	15 142	9%
12	5	47	9	79	3	1	144	17 127	12%
13	1	46	10	60	3	0	120	14 106	12%
14	3	50	6	53	7	0	119	16 103	13%
15	3	39	1	43	3	2	95	7 84	7%
16 & over	4	30	4	100	5	1	414	13 131	9%
TOTAL	30	533	88	937	54	13	1,654	171 1483	10%
% +	5.3%		8.6%		81%				

*This embraces only cases where there is "open". T.B. at home.

He quotes FERGUSON (53), of Saskatchewan, who tested 1,346 children in towns and rural districts of the Province. He found 56.6% positive reactors at 14 years of age. This included 162 Indians giving 92.5% positive results.

CALMETTE, GEYSER & LETULLE, (54) tested 1226 children in Lille, and found in the age group 5.15 years 366 (81.4%) of the children gave a positive reaction. In the total series of cases - ranging from under 1 year to over 15 years, they noted, that according to the death rate from Tuberculosis in Lille, only 24% of these children were destined to develop manifest tuberculosis.

HOFFA (55), discusses the PIRQUET reaction, and points out, that HAMBURGER'S view that practically every inhabitant in all European cities is infected with tuberculosis, must not be regarded as accurate, in view of CZERNY & MORO'S (56) more recent work, where they tested 7,000 individuals, and found only 2.5% 'positive'reactors in the first year of life, 23% 'positives' in the second year, 25% in the second to the fourth year and 40%-60% in from ten to fourteen years. He also points out that under nutrition falls into line with measles, acute miliary tuberculosis etc., as a/

a fallacy for a tuberculin reaction, and shows that in Germany, increase of food produced positive reactions in cases previously negative.

FURSTNER-RISSELADA (57), carried out the PIRQUET test on 1506 school children in the Hague. He used the usual technique and read his results at the end of 48 hours. Negative results were repeated, and it may be noted that only 17 children out of 220 (7.7%) "negative reactors" gave positive results with the second test.

His figures are as follow:-

YEARS of AGE	POSITIVE REACTION.
6	20%
7	20%
8	28%
9	32%
10	43%
11	30%
12	41%
13	50%

These figures give a much lower percentage than most published statistics dealing with industrial school children.

VONESSEN (58), tested 550 children at a school in Holn-Leindenthal, using full strength O.T.

The/

The children belonged to the better middle class. Positive reactions were considered to be those who showed a papule of at least 4-5 mm. in diameter, with a visible and palpable nodule. His results were as follow:-

NO. Children.	YEARS of AGE	POSITIVE REACTION.
129	6-7	49%
207	8-10	51%
146	11-12	64%
68	13-14	75%

Obvious tuberculous disease was only found in two of the above cases. The author points out that most of the previous statistics dealing with PIRQUET'S reaction are taken from orphanages, clinics or private cases, which should be considered as suspect material.

An interesting series of Tuberculin Tests, relative to tuberculous infection in childhood was carried out by CUNNINGHAM & RADCLIFFE (59), and in some respects run along the same lines as were attempted with the present series of observations.

346 Children were tested, and four tuberculin tests were carried out on each child, viz:-

2 PIRQUET tests, human and bovine, and

2 intracutaneous tests, human and bovine.

The result was, that 57.1% showed a positive reaction, with/

with an average age of 8.1 years, when all the tests were taken into consideration, and if the PIRQUET test alone had been used, 85% of all cases detected, would have been regarded as positive.

They also studied the relationship between glandular enlargements and the tuberculin test. The anterior cervical glands, epitrochlear and peri-bronchial glands of 165 cases were examined. The PIRQUET and intracutaneous methods were both used, and of these 88 gave a positive tuberculin reaction. They found the anterior cervical glands were enlarged in more than half this group of children. When co-relating the presence of these enlarged glands with the tuberculin reaction, it was found that in 57.9% of the "positive reactors" enlarged glands were present, while in 58.4% of the negative reactors, enlarged glands could be detected. These cases were, of course, patients at a clinic, but they go to show that cervical glandular enlargement may be present, without evidence of tuberculous infection. It should be pointed out that the authors of this paper do not describe their criterion for diagnosing "enlarged cervical glands".

Much the same result was obtained with the epitrochlear glands, viz:- 31.8% of those who reacted to/

to tuberculin and 30% who failed to react, showed enlarged epitrochlear glands.

The presence of peribronchial glandular enlargement was estimated by D'ESPINE'S[60] sign alone, and on this basis 48.8% of the 88 "positive reactors" showed a positive D'ESPINE sign, while those who did not react, showed this auscultatory phenomenon in 33.7% of the cases.

It will, therefore, be seen from this study that evidence of glandular enlargement and positive tuberculin tests, are by no means synonymous terms.

BRÜNING[61], tested with the PIRQUET reaction 350 well to do children of all ages, who came to him for complaints other than tuberculous, and found 91% gave a positive reaction.

GITTINGS & DONNELLY[62], tested all cases in the Children's Hospital Philadelphia, during the last ten years, and found the results demonstrated the high percentage of tuberculous infection with a comparatively low incidence of recognisable clinical tuberculosis in childhood.

Many other investigations could be quoted, but sufficient have been given to show that as age advances, the frequency of a positive reaction increases, and that statistics differ, with differences in the social/

social scale, hygiene and in different countries. Closer investigations have naturally been carried out, in hospital children than in so called, normal fit children, and this tends to give a larger figure than perhaps the facts of the case warrant.

DETAILS of the PIRQUET TEST in the PRESENT INVESTIGATION.

The PIRQUET test was the type of tuberculin reaction selected, because it could be carried out quickly and, therefore, a large number of boys could be done at the same time. The actual amount of tuberculin used in each test, would also be approximately the same.

The tuberculin employed was the old tuberculin of KOCH, prepared by LUCIUS & BRÜNING (63) and stamped "Made in Germany". A Human and a Bovine strain was obtained. It was realised that only one test could be carried out, as the school authorities were not too keen on what, they were afraid, might be interpreted by some misinformed parent as "an experiment", on their child. If an explanation of the procedure had to be given, it was feared that the enquirer would go away with the idea that their child was suffering/

suffering from tuberculous disease. For these reasons therefore, both a human and bovine tuberculin was used, in order -

(1) to have a double test, and

(2) to note any differences in reaction which might take place with the tuberculins used.

The usual technique in carrying out the test was used. The left forearm was thoroughly cleansed with ether, and the epithelium was scraped with a scarifier, just short of drawing blood, although in a good many cases a slight tinge of blood appeared. This was inevitable, as it was considered necessary to avoid an error, in not scarifying the epithelium sufficiently to allow of a proper test being carried out, A drop of human tuberculin and bovine tuberculine was then rubbed firmly into the respective abrasions. A control was not considered necessary. After the application of tuberculin had been made, the boy remained seated, with his arm bare, till the tuberculin was absolutely dry. Great care was taken in this part of the technique, for it was felt that any laxity of this item would invalidate the test, which could not be repeated.

The results were read 48 hours later, and any doubtful cases were again examined at the end of another 24 hours.

No case was considered positive, unless a definite/

definite red papule was clearly visible, and at the same time definite induration in this reddened area could be palpated. Both the human and the bovine reactions were read, and it was noted that the bovine reaction was never positive, unless the human reaction was also positive. In all cases when both were positive, the human tuberculin test always gave a more intense reaction. The reactions varied considerably in intensity, and the interesting point evolved, that there was only a very slight increase in"positive reactors" as one went up the school in age groups. The results are given below, beginning with the Junior boy and working up to the older groups.

The following table gives the result of the PIRQUET test in relation to the age of the boys tested.

\+ indicates what may be termed a normal reaction.
++ indicates a more florid reaction
(+) indicates a faint yet definite reaction.
\- indicates a negative reaction.

TABLE/

TABLE showing result of the PIRQUET TEST.

INITIALS	AGE	HUMAN	BOVINE
J.C.	5	-	-
D.M.	7	-	-
W.M.	7	-	-
E.W.	7	+	-
W.G.	7	+	+
J.G.	7	-	-
T.D.	7	+	+
A.S.	8	-	-
R.C.	8	+	+
W.M.	8	-	-
J.T.	8	-	-
J.D.	8	-	-
R.A.	8	-	-
D.T.	8	-	-
W.M.	8	+	(+)
D.B.	9	+	-
D.B.	9	-	-
J.B.	9	-	-
J.A.	9	++	++
A.M.	9	-	-
H.W.	9	-	-
G.M.	9	+	(+)
N.D.	9	+	-

INITIALS	AGE	HUMAN	BOVINE
C.M.	10	+	+
J.A.	10	++	+
A.P.	10	+	(+)
J.H.	10	-	-
J.L.	10	++	+
W.A.	10	+	+
R.G.	10	(+)	-
J.G.	10	+	+
G.M.	10	++	+
J.J.	10	++	+
R.M.	11	+	+
J.C.	11	-	-
C.J.	11	-	-
J.C.	11	+	+
J.M.	11	-	-
D.F.	11	-	-
W.D.	11	+	+
W.W.	11	-	-
A.E.	11	(+)	(+)
G.A.	12	+	(+)
L.M.	12	+	+
W.J.	12	+	(+)
T.M.	12	-	-
D.S.	12	+	-
A.M.	12	-	-
J.B.	12	-	-

INITIALS	AGE	HUMAN	BOVINE
J.G.	13	-	-
A.M.	13	-	-
J.M.	13	-	-
R.N.	13	+	-
J.H.	13	+	+
D.W.	13	++	++
A.M.	14	-	-
T.M.	14	-	-
T.M.(a)	14	-	-
A.M.	14	++	++
J.D.	14	+	+

In the above Table it will be noted, that no reaction takes place with bovine tuberculin in several cases, where a human tuberculin reaction is present. When both tuberculins react, the bovine was never more intense than the human.

It is, of course, impossible to draw any conclusions from such small numbers of cases here noted. The figures have, therefore, not been put into percentages.

They may, however, be briefly summarised in age groups, as giving a small sample of the school boy age in relation to the PIRQUET test.

TABLE/

NUMBER of BOYS.	AGED YEARS.	REACTORS.
1	5	1 negative.
6	7	3 negative) 3 positive)
8	8	6 negative) 2 positive)
8	9	4 negative) 4 positive)
10	10	1 negative) 9 positive)
9	11	5 negative) 4 positive)
7	12	3 negative) 4 positive)
6	13	3 negative) 3 positive)
5	14	3 negative) 2 positive)
TOTAL 60	=	29 Negative) 31 Positive)

This gives roughly - infected boys 50%
non-infected " 50%.

From this small group of figures it will be seen, that there is no very marked increase in infection as age rises, except for the very definite figures in the 10 years of age group.

PHYSICAL/

PHYSICAL EXAMINATION.

The general lines adopted in carrying out this part of the investigation, embodies the teaching of Sir ROBERT PHILIP.(2) The author first became acquainted with these methods in 1905, while a student at the Royal Victoria Dispensary. Since then, he has had, fortunately, very full opportunity of studying the refinements of these methods, both in the Royal Infirmary and the Department of Tuberculosis of the University of Edinburgh. He would also like to record his indebtedness to Sir ROBERT PHILIP, for the many years of teaching he has received from him, as well as the constant encouragement and help he has received in all his work.

Each boy, on appearing in the examination room, removed his boots and stripped to the waist, leaving on his trousers and stockings.

The following measurements were then recorded:-

Height

Weight

Stem Length

Chest

(a) Easy Respiration

(b) Full Inspiration

(c) Full Expiration.

The record of height and weight was taken in/

in the usual way: feet and inches, stones and pounds being used in the Records.

The length of the trunk, or "stem length" was taken and recorded, along the lines suggested by GEORGES DREYER (34), who writes:-

"The subject places the backs of the fingers upon the platform on which he sits, and, with the fingers pointing backwards and the knees flexed, lifts the lower portion of the body gently backwards until the lowest bony portion of the os sacrum is in contact with the measuring standard. The back is then straightened until the back of the head comes in contact with the standard. It will be found that different persons require to bend the knees in different degrees, in order to achieve this position. The head should be held neither up nor down, and the eyes should look straight forward. The measurement thus obtained, gives the distance between the ischial tuberosities, and the top of the head."

As a measuring "standard" was not available, the boy sat on a polished floor, with his back to a flat, wall surface, and the measurement made with a flat ruler on the top of the head, held at right angles to the wall.

The/

The chest measurements were made at the level of the fourth intercostal space. The reading for "Easy respiration" was taken while the boy was standing easily in front of one, with the arms hanging loosely at his side. He was encouraged to talk while this reading was being taken, so that the circumference during normal breathing, could be estimated as accurately as possible.

Physical Examination of the chest by inspection, palpation, percussion and auscultation was then carried out.

(a) INSPECTION included a general survey of the chest from the anatomical point of view, any local deviations from the normal being noted. The presence of visible veins in the upper aspect of the chest wall, was noted and classified.

If the veins were distinctly visible, but in no way prominent or obvious, they were classed as being "present in minor degree". If they were distinctly visible and more prominent, they were classed as "present in mild degree". If they were obviously larger, and at once arrested attention at a casual glance, they were classed as "present in moderate degree".

Two or three deep breaths were then taken, and/

and the chest viewed from the physiological point of view, to note specially any deviations from the normal as a whole or locally. Some care was taken with this procedure. The boy was seated on a chair and sat upright, with the head alone bent forward, while the inspection was made from the back, looking down on the front of the chest, the observer's eyes being fixed on the region from the second rib upwards to the clavicle. The outline of the neck was, at the same time scrutinised.

(b) PALPATION was employed, to confirm what could be determined by inspection. In addition to this, several very important points were investigated. Here one may parenthetically remark, that the investigation of what may be termed "systemic disturbances" was considered to be of considerable importance, as it is well known that in the process of development of tuberculosis, systemic disturbances are usually in advance of local phenomena. A failure to realise this simple fact, accounts for many cases of tuberculous disease being overlooked in their earliest stages. In a school of 'fit' boys, it is not easy to carry out minute examinations for systemic disturbances, such as pulse and temperature readings, and it was decided not to attempt this. Pulse records might/

might have been helpful, but there was so much nervousness, at times, amongst some of the boys, that it was considered unreliable to take any readings. Temperature records were also not carried out, as several of the boys were examined after exercise and, therefore, the readings would have been fallacious.

Two observations were, however, carried out systematically with each boy, viz:-

(1) A search for VASO-MOTOR PARALYSIS - and

(2) MYOTATIC IRRITABILITY.

(1) VASO-MOTOR PARALYSIS.

Many types of organisms at work in the system will produce a toxic disturbance of the circulation, and this can be recorded by an abnormal blushing of the skin, under mild stimulation.

The tubercle bacillus has the faculty of producing this phenomena, rather more readily than most other types of pyogenic organisms, without at the same time producing local phenomena. It is a well known fact that, when one is examining a patient with marked pulmonary tuberculosis, when sitting him up in bed, to examine his back, the bony prominences are all mapped out by well marked red lines due to the development of cutaneous hyperaemia on the areas which have sustained the weight of his body. This is a florid example of lack of vaso-motor tone, following toxic absorption./

absorption. To elicit this phenomena of loss of vaso-motor control, the skin of the front of the chest can be stimulated, by drawing the pad of the finger quickly and firmly, perpendicularly down each side of the chest, from the clavicular region. In a few seconds thereafter a blush follows in the track made by the finger stimulating the skin. This blush persists for a varying length of time. This phenomena of blushing, after cutaneous stimulation, is here regarded as Vaso-motor paralysis. It varies in degree, and the accurate recording of it gives rise to a little difficulty. The writer has adopted a time limit, to record the degree of reaction produced. A flush may appear at once, or be delayed for 15-20 seconds. It then gradually fades - the time varying in different cases. In this series, if the flush begins within 20 seconds of stimulation, and persists for two minutes, the report of VASO-MOTOR PARALYSIS: - POSITIVE is made. When the flush appears earlier, and lasts longer than this, the record is made VASO-MOTOR PARALYSIS: - POSITIVE IN MODERATE DEGREE. If a flush follows stimulation and disappears under two minutes, the record is made VASO-MOTOR PARALYSIS: - NEGATIVE. It should be emphasised, that a definite reaction only, is recorded as positive, a dubious reaction being discarded. This may, possibly, be taking too conservative a view, but when one is dealing with points in a physical examination, the personal/

personal factor of the examiner is always a slightly unstable item, and, therefore, two points have been kept clearly in mind, viz:-

(1) An attempt to use, as far as possible, equal pressure when testing the skin, and -

(2) The time factor in the appearance of the hyperaemia. Many apparently, perfectly healthy people who are not adipose, give some degree of 'flush' after digital stimulation, and it is to try to exclude such a group as this, that the time factor has been introduced.

(2) MYOTATIC IRRITABILITY.

The investigation of this phenomena was carried out in two ways.

(1) The pectoral muscles were stimulated in the same way as testing for vaso-motor paralysis, by drawing the finger across the pectoral muscles at right angles to their longitudinal fibres, and noting the reaction which took place, by observing the groups of muscle fibres standing out, as the stimulation passes downwards; a condition which might be termed "stranding" of the muscles.

(2) The pectoral muscles overlying the ribs are percussed directly by the index, or middle finger. When abnormal irritability of muscles is present, a small muscular swelling forms/

forms at the spot percussed. This muscular swelling is often referred to as a condition of MYOIDEMA, or "nodular swelling", and is present in many toxic states, but is exceedingly common in people suffering from tuberculous toxaemia.

WILLIAM STOKES (64), of Dublin, in 1829, first drew attention to this phenomena, in cases of pulmonary tuberculosis. He also pointed out, that the sign was present in other diseases causing lung or pleural disease.

SAMUEL WEST (65), also found this sign present in lung diseases, but noted that it was present in other diseases, where emaciation and loss of adipose tissue were present.

VERRIENTI (66), refers to this condition of muscular hyperexcitability as present in all stages of pulmonary tuberculosis, being more marked on the side of the active lesion.

SAINTON & THEODOESCU (67), attribute great diagnostic significance to this phenomena in differentiating pulmonary tuberculosis from emphysematous bronchitis. More recently L. DAUTREBAUDE (68), has investigated this reaction in 100 cases of pulmonary tuberculosis and, while admitting its presence in a variety/

variety of diseases, concludes that it is constant in pulmonary tuberculosis. He also says, that it is frequently present when no auscultatory signs of tuberculosis are to be found in the lungs, but where evidence of disease is revealed by radiography. A striking example of the value of this sign came before the writer some time ago.

The case was one diagnosed and operated on for gastric ulcer. Some months later, the case was seen in an emaciated state, and pulmonary tuberculosis was suggested as a diagnosis. The chest signs were not by any means conclusive, and on testing the wasted muscles, a very minor degree of myoidema was present. The writer, therefore, said it was not tuberculosis, and shortly afterwards, a non-tuberculous, mediastinal abscess was discovered, without any evidence of mediastinal or pulmonary tuberculosis. In the recent literature on this subject of myotatic irritability, it is obvious that too much stress has been put on the question of <u>pulmonary</u> tuberculosis, but more stress should be laid on the fact that it is part of the evidence in favour of a toxaemia - in many cases tuberculosis - which is produced by a lymphatic infection which has not yet revealed itself by any obvious local phenomena.

The/

The formula adopted in reporting this sign is as follows:-

When no muscular contraction can be seen on stimulation of the fibres, by drawing the finger across them, i.e. no 'stranding' of the muscles under stimulation, "MYOTATIC IRRITABILITY - NEGATIVE" is reported.

If this 'stranding' of the muscles is visible then "MYOTATIC IRRITABILITY - POSITIVE" is reported. If nodular swellings form by direct percussion of the muscles, then "+MYOIDEMA" is added to the report on myotatic irritability.

In this connection, it should be noted that since 1919, there seems to be a tendency to regard this muscular phenomenon as a new discovery. It is only a re-discovery.

Further, in Edinburgh, this phenomenon of irritability, has been taught by Sir ROBERT PHILIP for the past thirty years, as a sign of toxic disturbance, to be taken in conjunction with other signs, in basing a diagnosis of tuberculosis. He has always taught that it may be present in other toxic states. Recently, the writer has noticed its frequent occurrence in the acute phase of lobar pneumonia. It dies away a few days after a successful crisis.

(c)/

(c) PERCUSSION. This was carried out thoroughly in all cases. It was fully realised that much care would have to be exercised in this phase of the examination, as the personal factor was liable to vary with the degree of fatigue of the observer. To counteract this, as far as possible, one was fortunate enough to obtain the co-operation of a senior student, who had a highly trained ear, and was a pianist of considerable skill. In most of the cases he was present, when percussion was being carried out, and with his eyes shut, listened to the percussion, and recorded his results independently. In this way, it was hoped to eliminate the human error, as much as possible. The results of percussion were, therefore, recorded independently and then compared. Fortunately in every case agreement was obtained. The degree of difference between two notes, may have varied to a slight degree, but there was no difference as to which of two, was the higher pitched note. It was found that light percussion was the most reliable, in estimating differences in these children. Light percussion, in this series of cases, means the production of a definite, audible sound, clearly heard, at least two feet away, and not a question of resistance conveyed to the percussing finger. When heavy percussion was employed, differences of note became/

became less audible. The usual precautions to obtain accuracy of note, were carefully attended to, by trying, as far as possible, to exert equal pressure with the pleximeter finger, and equal power with the plessor finger throughout the examination.

The whole examination was carried through with much deliberation, and the occurrence of signs of fatigue, on the part of the examiner, at once caused the examination of that particular batch of boys, to be stopped for the day. The percussion results in each case are described, and placed in diagrammatic form on the charts.

A single line (|) indicates a definite, clearly detectible dullness, or rather impaired percussion note, while a dotted line (⋮) indicates a definite, but much less marked impairment of note, which is just detectible by careful technique.

During the examination of the back, the boy sat with his arms folded, the hands being placed on the opposite shoulders, and the head bent slightly forward. When the anterior aspect of the chest was being examined, the boy sat erect, without any strain on the chest muscles, with the arms hanging loosely beside him.

The expansion of the lungs at the bases was tested/

tested by percussion. The upper level being the lower limit of the lung resonance in easy respiration, and the lower level being taken as the limit of lung resonance, at the end of full inspiration. These observations were made in the scapular line and the distance between the two points was measured.

It may here be stated that RIVIERE'S (69), reflex bands of dullness were never noted in the cases here described. This may have been due to any one of three causes, viz:-

(1) Lack of percussion skill on the part of the observer.

(2) Their natural absence.

(3) Lack of acoustic perception.

(d) AUSCULTATION. The usual procedure was adopted in this part of the examination. The fact of harsher breathing being normal as the right apex was kept in mind, and only quite definite deviations from the normal are recorded, any doubtful respiratory abnormalities being discounted. The particular point in auscultation, however, which was specially investigated, will be termed "SPINAL AUSCULTATION". This was examined with very great care, from three points of view, in the hope of obtaining some definite findings, which could be co-related/

co-related to the radiograph pictures. This naturally raises the question of D'ESPINE'S sign (60), which will be referred to more fully later on. Suffice it to state here, that there is great lack of unanimity as to what exactly is meant by D'ESPINE'S sign, and secondly, one was never quite certain of being able to elicit the cardinal factor of the sign, viz:- this so-called echoing, at the end of vocalisation. It was, therefore, decided, after a fair trial, not to try to elicit this sign, for it was felt there would be a certain amount of unreliability about it.

Accuracy of interpretation in the physical signs elicited, was much to be desired. It was also considered necessary to investigate phenomena, about which there could be little or no dubiety, and phenomena which could be accurately described and be, at the same time, of easy realisation to anyone with average experience in auscultation.

Three observations by means of spinal auscultation were, therefore, made.

(1) AUSCULTATION of the WHISPERED VOICE.

A Binaural stethoscope, with a bell type of chest piece, was used, and placed over individual spines, the boy being asked at the same time to whisper/

whisper "one one one". Over the cervical spines, and in many instances, over the upper dorsal spines, a definite articulate, clear, whispered sound was audible, which diminished in intensity, as one proceeded downwards. The point at which this clear articulate (whispering pectoriloquy, practically) whispering ceased, was noted. In some cases it broke off quite abruptly, one spine giving a clear articulate note, and the one below, showing a fainter, more continuous sound. In other cases this change was not clear cut, but gradual.

(2) AUSCULTATION of the TYPE of BREATHING. The same procedure was adopted over the respective spines, while the boy breathed steadily through the nose, with arms folded in front and head bent forward. Definite bronchial breathing of medium pitch could be heard for a varying distance down the spine. In many cases, the break from bronchial to distant vesicular, or at least faint broncho-vesicular breathing, was sharply defined. In other cases, there was a fading of the bronchial into vesicular, through broncho-vesicular, without a clear cut division between two spines being determined. In doubtful cases, the two points were noted, viz:-

(a) The quality of the expiratory murmur, and

(b) Any <u>sudden</u> diminution of intensity of breath sounds.

If/

If the intensity suddenly diminished and the type of breathing was difficult to estimate, this sudden drop in intensity was regarded as the more important factor, and the record made accordingly.

(3) AUSCULTATION of the SPOKEN VOICE.

This was carried out in the same way. The boy maintained the same position, and the individual spines were auscultated, while the boy spoke the words "one one one" Again change in intensity of voice sounds were looked for here. It was, of course, found that rather a more arbitrary line of demarcation had to be taken here, as one proceeded down the spine, but with a little practice, one soon came to realise, that over the upper spines, there was a clear ring in the sound transmitted to the ear - almost an echoing quality - which stopped suddenly in some cases, and in others was frankly difficult to differentiate, more than by noting a progressive diminution in the intensity of the voice sounds, as one proceeded downwards.

In a large number of the boys, I had the advantage of the sharp ears of my senior student friend, although no real difference occurred in this part of the examination, as we purposely restricted our observations to what were considered quite clear cut - or lack of clear cut - phenomena, with definite acoustic changes/

changes on passing downwards.

Another point worth noting, in carrying out these spinal auscultation tests was, that an attempt was always made to get each boy to assume, as far as possible, the same position, viz:- arms folded in front, and a mild degree of spinal flexion. Tests were made, to see if the phenomena differed in any material way, while the boy was sitting upright. In the cases that were tested, the only difference was a slight diminution of intensity of voice sounds, or breath sounds, but no actual difference as to a definite change in the acoustic quality which one endeavoured to make the deciding factor in the test.

Further remarks will be made presently on (60) D'ESPINE'S sign and spinal auscultation. The descriptions of the results of spinal auscultation in each case are self explanatory, but it is well to emphasise the relative difficulty of estimating any change in character of the spoken voice, compared to the whispered voice, or to the type of breathing. An attempt has been made to illustrate the findings by diagrams on skeleton charts.

During the course of the thoracic examination, the heart was auscultated and any abnormality, apart from a sinus arythmia, noted. The size of the respective/

respective hearts will be seen on the radiogram.

A few references to D'ESPINE'S sign and Spinal Auscultation are interpolated here, to maintain the sequence, and because of their significance in estimating enlarged hilus glands. Thereafter a few remarks will be added, as to the methods of examining the other glandular areas, specially investigated.

D'ESPINE'S/

D'ESPINE'S SIGN and SPINAL AUSCULTATION.

Considerable diversity of opinion appears to exist as to what is really to be regarded as D'ESPINE'S sign. Reference to standard text books gives no unanimity of description. For example, POTTINGER (70), describes it thus:-

"The patient is required to pronounce some such numbers as 'ninety-nine' or 'one, two, three' as distinctly as possible, while the examiner listens with the ear, or a stethoscope with small chest piece, over the cervical and upper dorsal vertebrae. Over the cervical vertebrae, the voice is heard distinctly, and has clear tracheal characteristics. In normal children, this quality of the voice ceases immediately, at the seventh cervical vertebra, where the lung tissue begins. When the swelling of the bronchial glands exists, the tracheal character of the one persists below this point, and may be heard as low as the fifth dorsal. This is the portion of the chest, occupied by the bronchial glands, and the bronchial character of the sound is transmitted by the swollen glands, which surround the trachea and the bronchi sometimes filling the mediastinal space to the spinal column, producing a good medium for the transmission of the sound. Auscultation by the ear/

ear gives better bronchial sound than the stethoscope, but the latter enables one to differentiate more accurately and likewise causes an accentuation of the vocal fremitus. When auscultation of the spoken voice is uncertain, it is well to have the child whisper 'ninety-nine' and listen carefully and systematically from above downwards, over the upper thoracic spines, in the same manner as mentioned above".

CLIVE RIVIERE (69), says D'ESPINE (60) . . . . "auscultates the voice and breath sounds over the seventh cervical and first dorsal vertebrae, and finds, in cases of disease, a whispering echo added to the voice sounds, and tubular breathing here, and sometimes down to the fourth and fifth spine".

FISHBERG (71), quoting from D'ESPINE, describes the sign and states it consists in auscultation of the voice, especially the whispered voice, along the course of the trachea posteriorly. In listening along the cervical spines, the characteristic tracheal tone of each word is heard quite clearly. Normally, the clear voice stops abruptly at the seventh cervical spine, but if there be glandular enlargement, it is continued downwards to the first, or as low as the fifth dorsal spines FISHBERG emphasises the fact that D'ESPINE'S sign is not the mere transmission of vocal resonance, as heard over/

over normal lungs. It is the transmission of the tracheal timbre which counts.

SEWALL[72], HOWELL[73], and HONEY[74], are all strongly in favour of this sign, as significant of tracheo-bronchial adenopathy.

JOHN THOMSON[75], writes thus of D'ESPINE'S sign:- "In normal children on auscultating over the spine from above downwards, while the patient is speaking, the tracheal sound of the voice is found to cease abruptly at a point between the 7th cervical and 1st dorsal spines. When the bronchial glands are enlarged, however, this change does not take place at this point, but the voice alters in quality and becomes whispering in character, over the upper dorsal spines, in slight cases, and bronchophonic, in severe ones. This change may be audible over the first two or three dorsal spines, or, if the glandular enlargement is very great, as low as the fourth or fifth. The sign is most obvious, when the child speaks in a low voice, and, if he cannot be induced to speak, a bronchial quality of the breathing at the same place may be heard, and has the same diagnostic significance. If the bronchial breathing is distinct, it indicates considerable/

considerable and extensive glandular enlargement". He admits he has not had much experience of it.

Many authorities attach great importance to D'ESPINE'S sign, in the diagnosis of Tracheo-bronchial adenopathy. KLARE and DEHOFF (76), for example, consider its value established. They state the normal range in children varies with age, thus, children up to 7 years of age, show the sign to the 7th cervical vertebra; in those of 8 years of age to the 1st dorsal vertebra; up to 12 years of age to the 2nd dorsal vertebra; and up to 15 years of age to the 3rd dorsal vertebra. They examined about 400 radiograms of cases examined for D'ESPINE'S sign, and found agreement in 95.3% of cases over 10 years of age, and in 99% under 10 years of age.

CARROLL & GIBSON (77), studied D'ESPINE'S sign at a State Sanatorium in 411 children. They only found the sign in about fifty of the cases and, therefore, concluded that it did not occur indiscriminately. They found, however, that in 81.6% of the cases that gave the sign, there was clear evidence of hilus tuberculosis, when the cases were examined by the X-rays. They, therefore, consider that D'ESPINE'S sign should not be disregarded as part of the cumulative evidence, in forming a diagnosis of hilus tuberculous disease.

J/

J. L. MORSE (78), investigated 666 patients in his private practice. In 624 he found the characteristic change in the voice sound - a whispering quality added to the voice sound - to take place between the 7th cervical and 1st dorsal. In only 40 cases, was D'ESPINE'S sign on this basis, positive. He prepared a table of the positive cases, and shows that not more than 50% of these 40 can be classed as tuberculous. He, therefore, concludes, that the sign is uncommon in children of the well-to-do classes, and when present, it is not necessarily a manifestation of tuberculous disease of the mediastinal glands.

J. L. MORSE (78), being dissatisfied with the varying descriptions of D'ESPINE'S sign, quotes translations from two of D'ESPINE'S papers, and gives the following quotation from D'ESPINE (60);-

"The sign is most obvious when the child is made to speak or count in a low voice. The voice is then accompanied by an added whispering sound localised to one or two vertebrae, or possibly extending to the fourth or fifth. A bronchial quality to the respiration at the same place, has the same diagnostic value as the whispered sound. It is necessary to be content with this, if the child is too young to speak, but the bronchial breathing is a sign of enlargement/

enlargement already more considerable and more extensive."

MORSE communicated direct with D'ESPINE as to whether he had changed his mind, as to what he meant by his sign and received the reply:- "Aussi exacte aujourd'hui". MORSE concludes that the sign D'ESPINE originally called attention to, was a whispering sound, following the spoken voice and audible over the spinous processes. No such sound is heard normally, and D'ESPINE believed that this whispered sound heard just after the spoken voice, was the earliest sign of Tracheo-bronchial adenopathy. D'ESPINE also believed that an extension below the 7th cervical vertebra of the bronchial character of the voice, was evidence of enlargement of the tracheo-bronchial glands, but a later sign. Extension of the bronchial respiratory sound and impairment of percussion were still more advanced signs.

MORSE investigated 118 cases of children from 2-14 years of age, who were brought to the clinic for advice as to trivial conditions. The following points were specially noted:-

(1) Whispered voice after the spoken voice, i.e. D'ESPINE'S sign.

(2)

(a) The spoken voice.
(b) The whispered voice.
(c) The Respiratory murmur

The point at which change from the bronchial

quality/

quality to the vesicular quality being noted.

(3) The point where dullness on percussion began.

(4) Interscapular dullness.

He found the phenomena under the second division always clear and definite. The question of percussion differences were less definite.

He got the following results:-

(1) In 88 cases no true D'ESPINE'S sign was obtained.

In 24 cases D'ESPINE'S sign was heard through the 7th cervical spine.

In 6 cases it was audible below this spine as well.

(2) (a) In 90 cases the change from bronchial to vesicular spoken voice took place between the 7th cervical and 1st dorsal spines.

In 9 no bronchial voice was at all audible.

In 4 the character of the sound was undeterminable.

In 6 the bronchial quality was audible below the 7th cervical spine.

(b) In 87 cases the change from a bronchial to a vesicular whisper was between the 7th cervical and 1st dorsal.

In 22 cases the bronchial whisper was audible below the 7th cervical spine.

In 9 cases failure to co-operate and other difficulties arose.

(c) In 97 cases change from the bronchial

to/

to the vesicular respiratory murmur took place between the 7th cervical and 1st dorsal spine.

In 15 cases the bronchial murmur was audible below the 7th cervical spine.

In 6 cases the murmur was everywhere vesicular or indeterminate.

Spinal dullness stopped at the 7th cervical spine in 95 cases and above it in one. In one case no dullness could be made out in the neck.

In 21 cases, there was dullness below the 7th cervical spine, No interscapular dullness was found in any case.

MORSE gives a more detailed statistical analysis of D'ESPINE'S sign in these cases and says it was present in 17 cases, in which no other abnormal changes could be determined. On the other hand, it was absent in sixteen cases, where other signs were determined, although it coincided in 13 instances, where other signs were present. This detracts, to some extent, from its value. Further analysis of his figures are detailed, which need not be recounted. MORSE summarises his conclusions thus:-

"The sign to which D'ESPINE called special attention is a whispering sound heard after the spoken voice when the bell of the stethoscope is placed over the spinous processes. This sound is not heard under normal conditions. Normally the bronchial sound of the spoken and whispered voices and of the respiration does not extend below the seventh/

seventh cervical spine. Dullness on percussion over the spinous processes stops at the same level. Extension of the bronchial sound of the spoken and whispered voices and of the respiration, as well as of dullness on percussion, below the seventh cervical spine is abnormal, and has the same significance as the whispering sound after the spoken voice. The whispering sound after the spoken voice, D'ESPINE'S sign, is often the earliest and only abnormality. It may, however, be absent when one or more of the other signs are present. The whispered voice is a somewhat more delicate test of pathological changes in the tracheo-bronchial region than is the spoken voice. The respiratory sound has an intermediate value. The value of percussion over the spinous processes is about the same as that of the respiratory sound. Interscapular dullness is a late sign, and is found only when the pathologic changes are considerable".

This article has been abstracted in some detail because it gives, in fact, a similar line of investigation to that carried out on the subjects of this thesis, before, however, this American article was published.

It will, therefore, be seen from the above quotations to D'ESPINE'S sign that considerable diversity of opinion exists, as to what actually constitutes

the/

the sign, and the significance to be attached to it. It appeared obvious to the writer that, in addition to reasons already stated, it should not be included in this series of observations.

THE GLANDULAR AREAS.

The anterior cervical glandular and axillary regions were palpated with care. The tonsillar glands were specially searched for, and when present in definite form were noted. The small shotty glands above the clavicle, were also carefully searched for, and their presence indicated in the Charts.

When charting these findings, an attempt has been made to indicate, approximately, their respective size and frequency. In every case, some degree of glandular swelling was to be made out; but in stating this, it is only fair to say, that a most rigid scrutiny was made, and even tiny glands that felt only like "sparrow-hail" shot, were included.

In all the cases reported, no obvious glands were visible when the boy was at rest, although here and there, one or two glands could be seen on raising the chin and moving the head about.

No special note was made about the posterior occipital glands, and certainly no large occipital glands were discovered.

In/

In a few cases only axillary glands were made out. No attempt has been made to estimate the presence of abdominal glands.

RADIOGRAMS/

RADIOGRAMS.

The radiographic study of the thorax is now considered by many physicians as part of a routine clinical examination. There is no doubt that in recent years, great advances have been made in this department of X-ray work, and yet, when one comes to study individual cases, in the light of clinical findings, one is struck by the diversity of shadows obtained, and different interpretations put on these shadows. It is much to be desired that some standard, radiographic appearance of the thorax should be obtained, but it is questionable if this is possible. More, perhaps, may be obtained as the 'stereo' photograph is more used. By this latter method one can estimate the depth at which a shadow is placed, this being impossible when dealing with an ordinary photograph.

Another difficulty encountered in dealing with radiograms, is the fact that reproductions in journals or books, give little detail and, therefore, much is lost in the process of printing. Hence, if one is trying to interpret an author through his writings, the chance of failure of a correct valuation is considerable.

The writer has also been impressed with another aspect of the question which lies in the hands of/

of the radiologist, or technician, who takes and 'develops' the photograph. Differences of X-Ray tube, time exposure, type of plates etc., have all to be taken into consideration. This question, of course, is highly technical and cannot be touched on here. Two pairs of photographs, however, are here given, which were taken from two boys, under identical conditions, as far as was humanly possible, as to time exposure etc. by DR. PRICE - the only difference being that the first photograph of each pair was taken during full inspiration, and the second photograph during full expiration. It will at once be seen that in both cases,more particularly in the first, "Norman Duncan", the difference in detailed outline is considerable, and certainly makes one wonder if the difference in phase of respiration can alone account for this. The writer hesitates to express an opinion, but thinks there must be something more in it than just the difference of respiratory phase. Detailed descriptions of these photographs follow later.

In reading articles on this subject of thoracic radiographic interpretation, the writer has noted that, not infrequently, the phase of respiration has not been recorded before the findings are described. In carrying out any radiogram of the thorax one/

one has to keep in mind that the whole situation has to be "sized up." It is not only a question of Lung densities, but a due consideration of

(1) The position of the ribs,

(2) The central cardio-vascular shadow,

(3) The root shadow of the lungs,

(4) The Parenchyma lung shadow and

(5) The pleural shadow, with a due appreciation of the position of the scapula.

When this work was begun, the writer was unaware of any extensive series of X-rays relative to the chests of supposedly normal children. He, therefore, had in mind chiefly two questions when this section of the work was begun, viz:-

I. Is there a 'normal' X-ray chest for children?

II. Do the variations of root and parenchyma shadows correspond with physical findings in such children?

He realised that sixty boys constituted rather a small group, but it was thought that, if much deviation took place in this group, it would, at least, give an index of what was to be expected in any larger group.

After the clinical and radiographic examinations had been completed, an important report on similar, but much more extensive, lines was published in the United States of America. (79) The National Tuberculosis Association of America organised/

organised the work. The paper referred to is entitled "Clinical and X-ray findings in Normal Children." The work was undertaken by three Physicians and three Radiologists, working in three pairs, i.e., a physician and radiologist working on the same set of cases, but keeping their results independent of each other till the final discussion was undertaken. In all, over 500 normal children were examined.

This "Team Work" study has now become so well known, that detailed reference to it is hardly necessary, but it may perhaps be advantageous to insert here the conclusions come to by the two groups of workers, viz., the clinicians and the radiologists:-

The Clinicians, (AUSTRIAN, LANDIS and BLACKFAN)(79) say:

" The foregoing facts have been detailed at some length to establish the major thesis that, clinically, the ideal, normal child is a hypothetical impossibility. Children, apparently healthy, symptom-free and active, show on careful examination many deviations from fixed standards, variations that must be interpreted as within physiological limits; standards of height and weight must be elastic; measures of resonance and of resilience of the chest must not be rigid and estimates of acoustic phenomena must permit of a range of difference from the ideal. These facts, clinical experience established beyond peradventure, and/

and they suggest a corollary, namely, that X-ray examination of the chest of such children may be expected to show comparable deviations from a fixed ideal roentgenogram.

The studies reported, fortified by past experience, warrant the following conclusions:

(1) The data obtained on percussion and auscultation of the lungs of normal children show wide variations from a fixed standard. These variations are usual and are considered to be within normal limits.

(2) Inasmuch as the changes referred to are dependent often upon alterations that persist as the residua of past infections of the respiratory tract, it is obvious that a careful anamnesis, with special reference to all infections, is necessary if diagnostic errors are to be avoided. Even a history carefully taken is often unreliable, as minimal infections are soon forgotten by many and among the unintelligent classes even more significant indispositions are not readily recalled.

(3) Failure properly to evaluate these deviations from a fixed standard will often lead to the unwarranted diagnosis of disease and to even less justifiable treatment.

(4) With a proper appreciation of the widest variations/

variations that the normal may present from the ideal, the informed clinician is better able correctly to understand the findings of the Roentgenologist, and each, cooperating with the other, is less liable to error.

(5) D'ESPINE'S sign as indicative of enlarged tracheo-bronchial lymph nodes is of little value.

(6) Recognition of and familiarity with the foregoing data is of cardinal and practical importance to every patient, potential and established. Without a proper appreciation of the facts set forth, no intelligent differentiation between a normal and an abnormal respiratory tract can be made.

In brief, to establish the presence or absence of disease, it is imperative that all data - clinical, laboratory and roentgenographic - must be evaluated and correlated and that no one fraction of the evidence be stressed to the exclusion of the others."

The Radiologists (PANCOAST, DUNHAM & BAETJER) (80) say:-

"THE NORMAL CHEST. The normal chest of the child from the roentgenologic standpoint is subject to such wide variations within normal limits as to be beyond the possibility of exact description.

HILUM SHADOW. The conglomerate shadow commonly called/

called the hilum shadow, when found lying entirely within the inner third or zone of the lung area can be disregarded, (or regarded as normal) except where it is made up of a solid mass of homogeneous shadow giving undoubted evidence that it represents a growth or mediastinal pleurisy.

CALCIFIED NODES. Calcified nodes at the root of the lung, without evidence of lung disease, are of no significance except as a possible evidence of some healed inflammatory condition, possibly, but not necessarily, tuberculous. They are a common finding in normal chests.

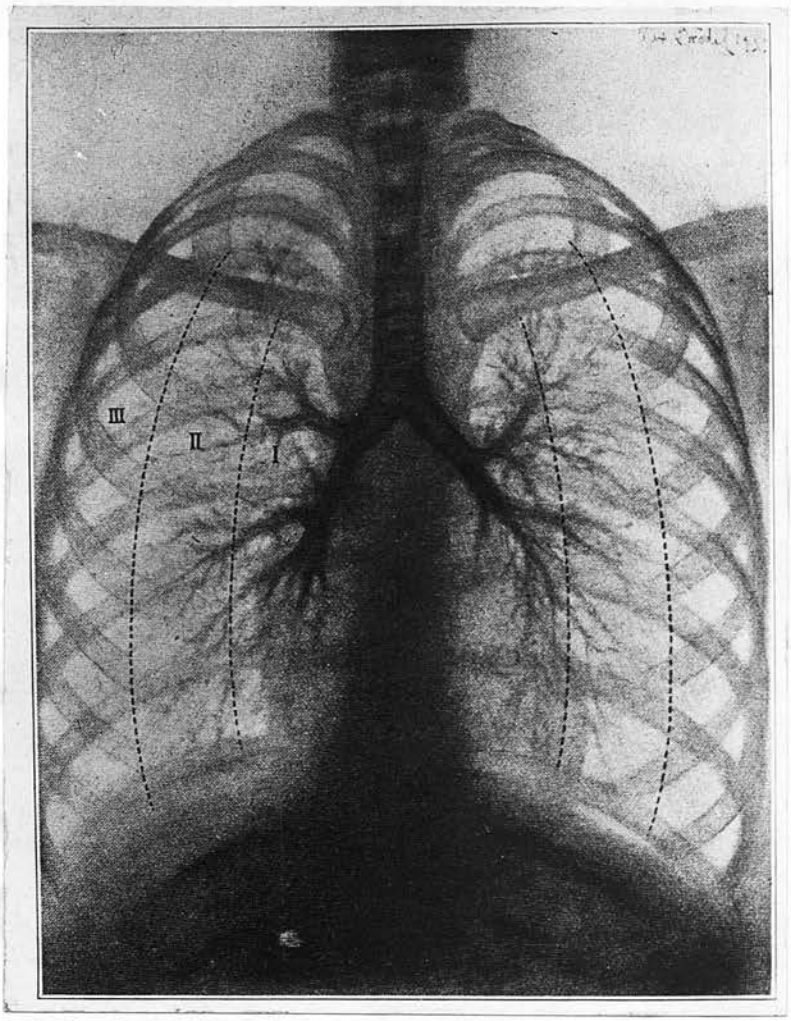
DENSITY and THICKNESS of TRUNK SHADOWS. In the normal lung the bronchial trunk shadows are not visible in the extreme apical regions. For convenience of description the remainder of the lung is divided into three vertical zones, extending outward from the lateral border of the spinal shadow to the lateral chest border.

The inner zone contains the root shadows.

The mid zone contains the trunk shadows, gradually fading out into their final subdivisions.

The peripheral zone contains radiating lines from these and fading off before the periphery is reached.

Where/



Copy of Composite Photograph suggested by the X-Ray Section of the AMERICAN COMMITTEE.

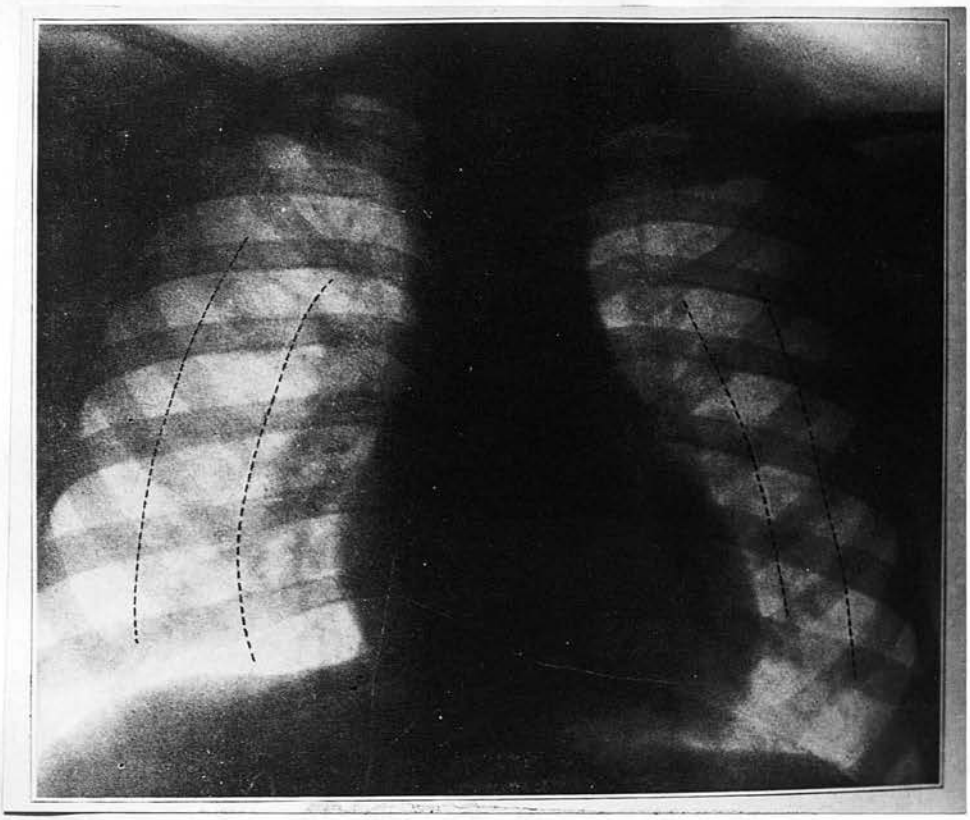
Where in the mid zone or peripheral zone, these shadows do not disappear in the characteristic fashion described, the appearance may be evidence of a variety of conditions, past or present, of an inflammatory nature or otherwise. It may accompany a tuberculous process, but is not necessarily indicative of tuberculosis.

IMPROPER or MISLEADING TERMS. The use of the terms "peribronchial tuberculosis" and "parenchyma tuberculosis" is not to be recommended in the interpretation of roentgenograms of the chest. Until corroborated by laboratory or clinical findings, the use of the terms "active" and "quiescent" should not be definitely applied to evident lesions demonstrated on plates."

A reproduction of the composite photo suggested by this group is inserted here.

Reference may also be made to two other articles along the same lines.

PATEN & ROWAND (81), investigated by radiograms, the chests of very young infants, with a view of recording the differences in appearance as they grew older. They show that even in their youngest infants shadows are to be seen in the hilus region, specially, of course, on the right side. Their photos have, no doubt, lost something in their reproduction, but even in/



+2

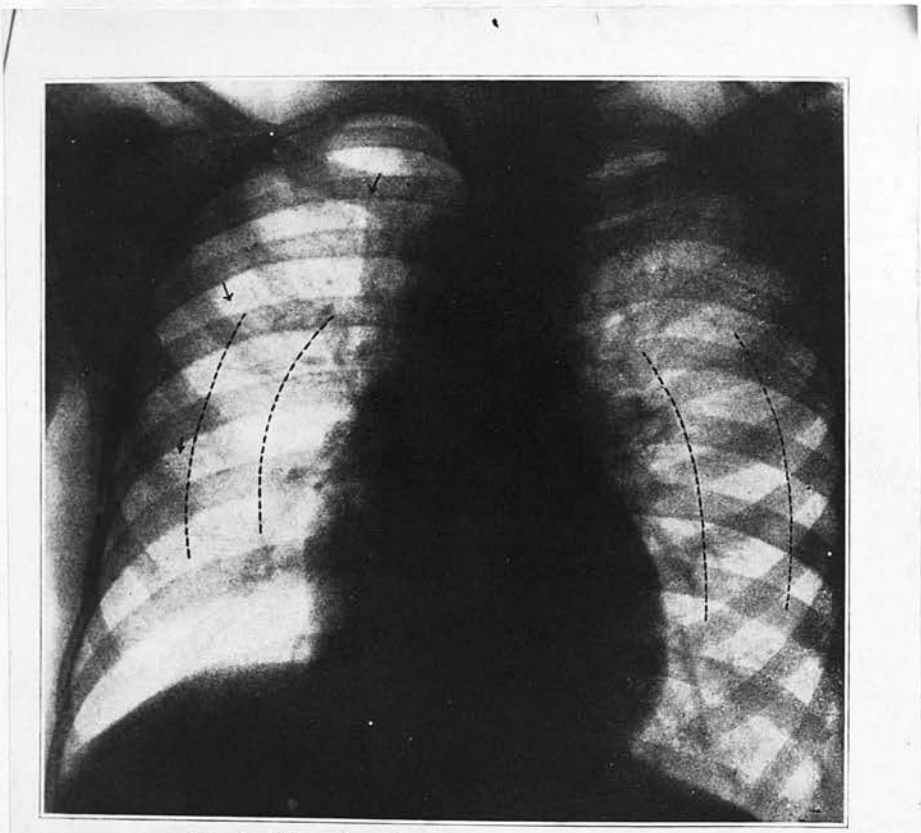


Fig. 3.—Normal subject with a grading of 3 +.

+3

REPRODUCTIONS FROM ARTICLE

by

WILSON, EDWARDS & LISS.

+ 1

in one infant, 21 days old, there is a right sided hilus shadow, which is quite well defined and compares favourably with some cases reported in this series - the youngest child of which is 5 years old.

The other article bearing on this point, is by WILSON, EDWARDS & LISS [49a], to which reference has already been made (See page 60). They attempted to classify the X-Ray findings in three Groups, along the lines of the above Special Committee investigations. Reproductions of their photos are here given, and it will be seen that they are not very convincing, as differentiating from what they term +1, (shadows on the inner third only), +2 (shadows extending to the middle third), and +3 (shadows extending to the other third).

The cases reported in this series, were reviewed from this classification point of view, but it was impossible to group them in this way with any degree of accuracy. Two difficulties arose. In the first place, the actual photographs differed a good deal in photographic technique, and some of the boys moved, giving a blurred effect. Secondly, it was noted that no clear cut grouping could be obtained, because the differences from one group to another were very faint, and in many, rather heavy root shadows were present, with or without branching, while others showed faint or ill defined shadows at the hilus, with

again/

again, variations in peripheral branching. No classification on this line has, therefore, been attempted.

PROCEDURE for RADIOGRAMS.

The writer was fortunate enough to enlist the services of Dr. EDMUND PRICE, who kindly took all the X-Ray plates at his house. He wishes here to express his grateful thanks for the kindly and generous help Dr. PRICE gave in carrying out this section of the work. All the radiograms are Dr. PRICE'S work, the interpretation thereof, being wholly carried out by the writer.

Boys were sent in batches of four. They were instructed to draw in a long breath, and the exposure was then made with the plate in front of the thorax. It will be noted, that about 15 of the cases reported upon, have no radiograms. This is due to the fact that these boys could not cooperate, being too young or too nervous, to understand what was required of them. In several plates it will be noted, that the boys have moved, showing the necessity for cooperation.

The general conclusion to be drawn from this section of the work, in relation to the Physical Examination, and specially Spinal Auscultation, will be found in the General Summary and Conclusions which follow this section.

As the clinical records, diagrams and radiograms/

radiograms have, for convenience, been put in a section by themselves, it may not be out of place to give here, a detailed description of radiograms taken just recently by Dr. PRICE, from two of the senior boys of the school, one of which, Norman Duncan, appears in the case records at an earlier age. Both boys were perfectly healthy when the X-Rays were taken. Duncan had a positive PIRQUET reaction 3 years ago. The other case, Thomson, had no PIRQUET test carried out.

N.B./

N.B. Unfortunately the peripheral aspect of these photos had to be cut off to fit the regulation thesis size. It was, obviously impossible to fold them to the correct size.

NO. I. NORMAN DUNCAN.

A. FULL INSPIRATION:-

The Ribs are equally spaced on both sides.

The Heart is of average size.

The Root of the Right lung is represented by a generalised mottling throughout, in which there are small and tiny opaque areas. Branching shadows to all areas are well defined, the base giving an appearance of increased translucency. The Root of the Left lung is also represented by a mottled appearance with an irregularly rounded shadow, just above its centre. Branching is well marked in all areas. The apices are obscured by bony structures.

B. FULL EXPIRATION:-

The Ribs are equally placed on both sides.

The Heart shadow is much broader.

The whole appearance of the hilus and lungs shows a lack of "crispness" when compared with the former plate. The actual root shadow on the right side is more defined, and the opaque dots are less easily distinguished and not so numerous, as in the former plate. Branching towards the periphery is/

NO. II. THOMSON.

A. FULL INSPIRATION:-

The Ribs are equally spaced on both sides.

The Heart is of average size.

The Root of the Right lung shows a denser, more defined, central shadow, almost indistinguishable from the right side of the heart. There are the usual small and tiny opaque dots. There are two quite definite circular shadows towards the upper and outer aspect of the hilus region. Branching is fairly well marked, but of a mottled appearance. The Root of the Left lung is well marked, and also shows the usual opaque areas. Branching is more clearly defined on this side.

Both apices are obscured by bony structures.

B. FULL EXPIRATION:-

The Ribs are equally placed on both sides.

The Heart assumes a more globular appearance.

The Root of the Right lung maintains its general contour, but is more sharply defined. The opaque dots in the upper part of the hilus region are less clearly defined, and not so numerous. The circular shadows, so well seen on full inspiration, are not visible. Branching shadows are still/

still rather mottled.

The Root of the Left lung gives the eppearance of having contracted, and become a little dense. Opaque dots are not so clearly defined, and the branching shadows are less distinct. The apices are clear and normal.

A study of these two pairs of photographs brings out several points worthy of note.

(1) There is a very distinct difference in the shadow cast at the end of full inspiration and the end of full expiration.

(2) The Heart shadow naturally differs in the two phases.

(3) The presence of what has been termed "opaque dots" varies according to the phase of respiration. The interpretation of these opaque areas is uncertain. Some would regard them as healed inflammatory reactions, e.g. tuberculous, others would say they are blood vessels, seen at right angles, others again, would term them part of the bronchial cartilage. Reference will be made to this subject in the general summary.

(4) There is no standard hilus shadow. These two boys were picked by the Head Master as senior boys thoroughly fit mentally and physically. They show two different types of root shadow. In No.I. the root/

root is ill defined, while in No. II it is quite clearly defined, even in both phases of respiration. If any classification were to be made in the series embraced in this thesis, the writer would feel disposed to classify them as :-

I. Hilus relatively clear;

II. Hilus indistinct.

Even on this basis, however, no co-relation exists between the X-Ray picture and other findings determined by clinical investigation.

Considerable discussion has taken place as to the structures which go to form the hilus shadow. OVEREND (82), says:-

"Certain linear impressions, arborisations and diffuse mottlings have been attributed to,

a) the walls of the bronchial tree,

b) to shadows cast by the blood vessels and especially the arteries,

c) to opacities occasioned by thickened lymphatics, presumed to be present in the early stages of tuberculosis and par excellence in certain types of chronic fibroid and chronic minor phthisis, and

d) to a summation of the positive shadows assumed to each system and emphasised in disease by the incidental fibrosis of individual components."

He points out that inflation of the bronchi of the cadaver, or during life, demonstrates, by this process, that the bronchi become less visible. He considered that probably the densities in the hilum and/

and lung itself, are composed mainly of blood vessels.

FRASER & McRAE (83), realise that more attention is now being paid to tuberculosis in children, specially in relation to tracheo-bronchial gland enlargement. They have studied a considerable mass of data from the point of view of earlier diagnosis in children and refer to X-Ray findings. They warn their readers about the difficulty in establishing a normal picture, but point out, as a child grows older, dust inhalations and infections give rise to more distinct shadows. They consider - "The hilus shadow is produced by lymph nodes, thick walled bronchial tubes, blood filled vessels and connective tissue binding them together, and it is to be noted, that these shadows increase in density and area, whether a history of infection is obtainable or not".

They also remind their readers, that Lymphadenopathy is extremely frequent after the common, specially respiratory tract, diseases of children. They say:- "At this point let us urge against the tendency to read tuberculosis into films showing large hilum shadows, unless these other causes can be excluded".

PIERSON (84), conducted a clinical and X-Ray investigation, into children of various ages, from one day old, and in a group of 80, whose ages varied from

3/

3-12 years, he found 30 showing what were regarded as pathological X-Ray findings, yet nothing abnormal could be made out by ordinary clinical methods. In three of these cases, the PIRQUET test was positive. They, therefore, consider the X-Ray test is too critical, and point out that children brought up in poor conditions, show much more lung markings than those in ideal surroundings.

From this short survey, it will be obvious, that X-Rays findings in the chests of children, have to be interpreted with much caution and in relation to other facts, ascertained from the history and further examination of the case.

The records and radiograms of the Cases examined, naturally follow here, but have been collected into a separate volume for convenience.

GENERAL/

GENERAL SUMMARY and CONCLUSIONS.

The study and records of Sixty-one, apparently healthy schoolboys, have been made the basis of this Thesis. Full details of these Cases are recorded in Volume II, for the sake of reference, convenience and compactness. The Cases are placed in order of their respective weights, beginning with the lightest. The "case numbers" refer to the serial numbers used in the tables which follow.

In drawing conclusions from the study of these Cases, it must be remembered, that the group consists of a small number of boys. They have the advantage, however, of being well fed, well housed, and well disciplined, as they are at a boarding school.

It must also be remembered, that the separate groups of observations were made, as far as possible independently of each other, e.g. Physical Examination was made at a different time from the PIRQUET test, and the result of the physical examination was unknown when the PIRQUET test was taken. The Vital Capacity reading was taken before the result of the Physical Examination was recorded. Finally, the X-Ray photographs were taken some weeks after the physical examination. This method may have its disadvantages, but it has the advantage/

advantage of unbiased evidence, when the grouping of results came to be considered. This, in fact, was one of the main objects of undertaking this research. The question of physical fitness also entered into the investigation.

Conclusions will be taken up under the following headings:-

I. STATISTICAL ANALYSIS:-

a) Vital Capacity readings.

1. In relation to Weight, Stem Length and Chest Measurement.

2. In relation to PIRQUET reaction.

b) Presence of cervical glands and PIRQUET reaction.

II. CO-RELATION BETWEEN PHYSICAL FINDINGS AND RADIOGRAMS.

III. RADIOGRAPHIC INTERPRETATIONS.

I/

I. STATISTICAL ANALYSIS.

a) (1) Vital Capacity readings.

In reporting the clinical examination of each boy, the Vital Capacity is recorded. In addition to this, the figure recorded in DREYER'S (34) TABLES is given opposite each record of WEIGHT, STEM LENGTH and CHEST MEASUREMENT. This was done in order to compare the actual readings made, with figures given by G. DREYER'S formulae. An attempt was made to estimate which of the measurements gives the nearest result in vital capacity reading, to the DREYER figure.

As has already been pointed out, DREYER'S figures are recorded in ccs., while the writer could only take his figures to two places of decimals. The difference in arithmetical calculation was found to be so trivial, that it could easily be discounted, without any serious deviation of results.

Before detailing the statistical tables, it may be remarked that, although a homogeneous group of boys was examined, they show extreme irregularities, when regarded individually. They form a very small number of cases and, therefore, they have been examined individually, in relation to DREYER'S standard tables. The suitability of this standard table may be questioned, as practically no information is given as to its mode of compilation, apart from the use of the mathematical/

mathematical formula.

DREYER'S[34] formulae for Males is as follows:-

$$W = 0.38025 \times \sqrt[0.319]{\lambda}; \quad W = 0.662 \times \sqrt[0.365]{ch}$$

$$Ch = \frac{\lambda 1.1442}{2.00148}; \quad V.C. = \frac{W 0.72}{0.69}; \quad V.C. = \frac{\lambda 2.257}{6.1172};$$

$$V.C. = \frac{Ch 1.973}{1.5595.}$$

W = Weight of body in grammes.

λ = Length of trunk in centimeters.

Ch = Circumference of the chest in centimeters.

V.C. = Vital Capacity in cubic centimeters.

The Constants for Vital Capacity represent

Class A. (See p./3/).

The nature and extent of the data from which these tables are derived, is not stated. No information is given as to the method employed in finally graduating the original date. A further point is worthy of mention. The class of case analysed, embraces the extreme limit of the tables - so much so, that in a few cases, corresponding Vital Capacity readings (DREYER) are not available. In these circumstances, it would be unwise to place much faith in the reliability of

our/

our examination as regards detailed information, but we may probably accept the results as correct, in so far as they relate to questions of tendency, and general movement, that is, broad averages over the whole group, or any large part of the group.

Before proceeding to give the TABLES and CHARTS in detail, one should explain the term - 'CLASS C', as used in reference to DREYER'S figures. DREYER pointed out that differences existed between individuals who appeared in good health, but in one case lived an outdoor life, or at least took a good deal of exercise, and those who lived a sedentary life. He, therefore, considered it necessary to allow for these differences, and grouped individuals into three classes, viz:- A., B. and C. His tables are used to assess physical fitness.

CLASS A. includes Navy, Army and Police personnel, athletes and active sportsmen, University students and Public School Boys, Blacksmiths, Boilermakers, etc.

CLASS B. includes Professional and Business men, Railway men, High grade mechanics, children in upper grade schools etc.

CLASS C. includes Tailors, shopkeepers, shoemakers/

shoemakers, printers, potters, painters, ELEMENTARY SCHOOL CHILDREN, Factory Children, etc.

It will, therefore, be seen, that the figures of Class C. Vital Capacity, must be used as our comparison.

TABLES are now submitted, to show the differences between the actual vital capacity observed, and the standard vital capacity figures of DREYER, as obtained from -

I. WEIGHT

II. STEM LENGTH, and

III. CHEST MEASURE.

N.B.

In the three following Tables, black figures refer to minus percentages, while red refer to plus percentages.

In this grouping it will be noted that the cases are taken in order of weight beginning at the lightest and working upwards.

"Actual" Vital Capacity figures are given as four figures to correspond to the four figures used in DREYER'S tables. This means that 0 is added to each actual reading. In working out the percentages, it has already been pointed out that the arithmetical difference is so slight as to be negligible for practical purposes.

TABLE/

DIFFERENCE between ACTUAL VITAL CAPACITY

and

STANDARD VITAL CAPACITY as obtained from WEIGHT.

SERIAL NUMBER	WEIGHT st. lbs.	VITAL CAPACITY	STANDARD VITAL CAPACITY	PERCENTAGE DEVIATION from STANDARD.
1	3 0½	1100	1506	-27
2	3 1½	1100	1532	28
3	3 3	1050	1569	33
4	3 4¾	1050	1613	35
5	3 6½	1400	1657	16
6	3 8	1150	1693	32
7	3 8	1220	1693	28
8	3 8½	1460	1705	14
9	3 8½	1220	1705	28
10	3 9	1250	1717	27
11	3 9	1000	1717	42
12	3 9	1700	1717	1
13	3 10½	1350	1754	23
14	3 10½	1400	1754	20
15	3 11	1300	1766	26
16	3 11½	1480	1778	17
17	3 12	1250	1790	30
18	3 13	1400	1813	23
19	3 13½	1450	1825	21
20	4 0	1330	1837	28
21	4 0	940	1837	49
22	4 0	1400	1837	24
23	4 0½	1800	1849	3
24	4 1	1650	1861	11
25	4 1	1450	1861	22
26	4 1½	1500	1873	20
27	4 1½	1450	1873	23
28	4 2	1520	1884	19
29	4 2½	1800	1896	5
30	4 3½	1600	1919	17
CF		40770	52831	692

SERIAL NUMBER	WEIGHT st. lbs.	VITAL CAPACITY	STANDARD VITAL CAPACITY	PERCENTAGE DEVIATION from STANDARD.
BF		40770	52831	692
31	4 5	1500	1954	-23
32	4 7	1610	2000	18
33	4 7½	1600	2011	20
34	4 8	1800	2022	11
35	4 8	1400	2022	31
36	4 8½	2500	2034	23
37	4 9½	2060	2057	0
38	4 10	2200	2068	6
39	4 10	1800	2068	13
40	4 10½	2190	2079	5
41	4 13	2000	2135	6
42	5 1	2100	2179	4
43	5 1½	2000	2190	9
44	5 3½	2050	2234	8
45	5 4½	2300	2256	2
46	5 4½	2300	2256	2
47	5 5¾	1950	2284	15
48	5 6	2190	2289	4
49	5 7	2600	2310	13
50	5 7½	1750	2321	25
51	5 8	2100	2332	10
52	5 9	2550	2354	8
53	5 10	2200	2375	7
54	5 10½	2120	2386	11
55	5 11	2150	2396	10
56	5 12	2050	2417	15
57	6 0	2500	2460	2
58	6 2	2200	2502	12
59	6 5	2700	2564	5
60	6 7	2100	2606	19
61	9 8	4200	3443	22
Total		107540	123435	963 88

Extreme Deviations -49 and 23 Range = 72

Total Deviations 1051

Average Deviation $\frac{1051}{61} = 17.2\%$

Net Total Deviation $\frac{123435-107540}{123435} = 12.9\%$

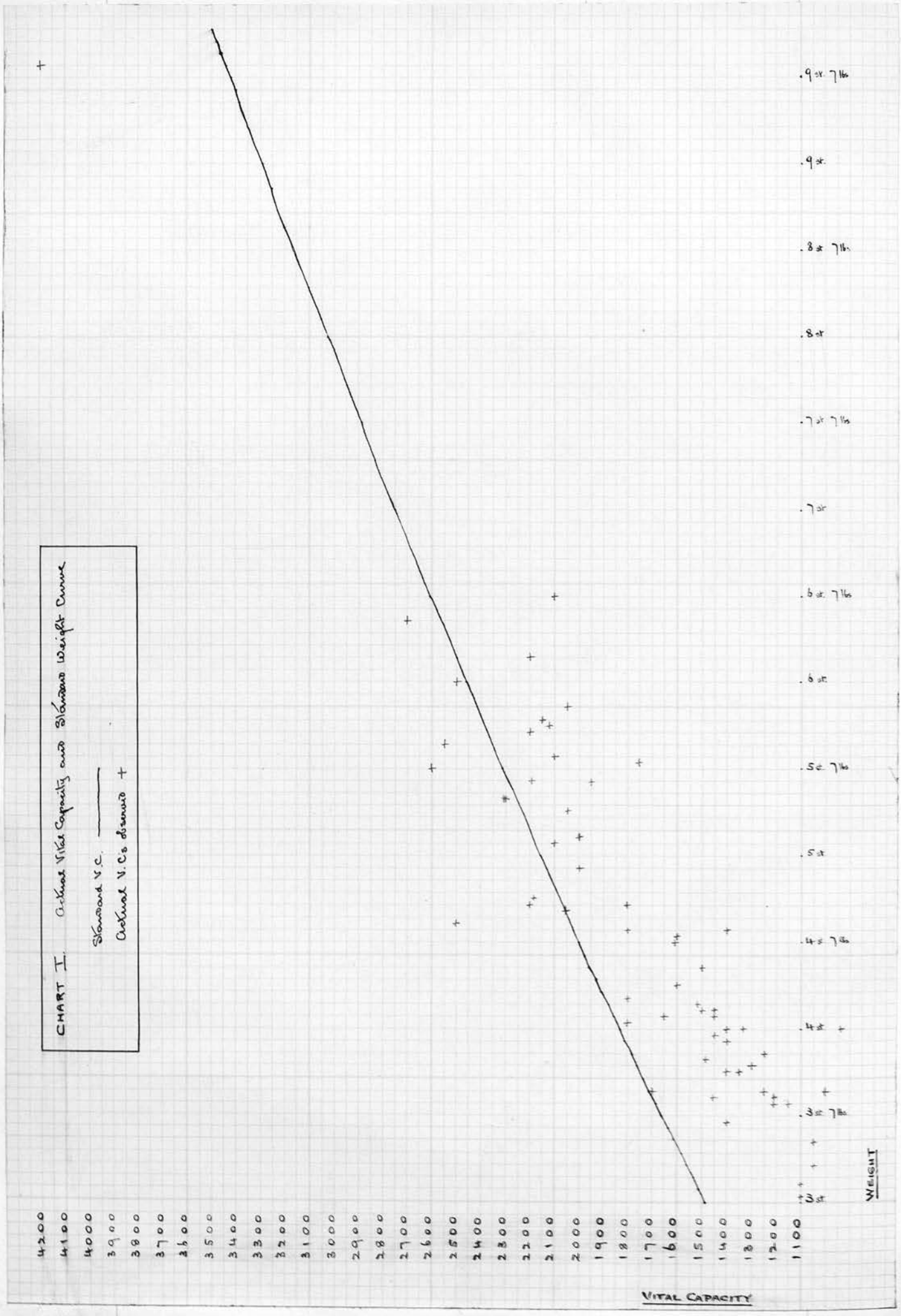


CHART I. Actual Vital Capacity and Standard Weight Curve
Standard V.C. ——
Actual V.C.'s denoted +
VITAL CAPACITY
WEIGHT
4200
4100
4000
3900
3800
3700
3600
3500
3400
3300
3200
3100
3000
2900
2800
2700
2600
2500
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
.9 st. 7 lbs.
.9 st.
.8 st. 7 lbs.
.8 st.
.7 st. 7 lbs.
.7 st.
.6 st. 7 lbs.
.6 st.
.5 st. 7 lbs.
.5 st.
.4 st. 7 lbs.
.4 st.
.3 st. 7 lbs.
.3 st.

TABLE II.

N.B.

The same sequence is maintained here. The shortest "Stem length" heads the list, followed by increasing length.

DIFFERENCE between ACTUAL VITAL CAPACITY

and

STANDARD VITAL CAPACITY as obtained from STEM LENGTH.

SERIAL NUMBER	STEM LENGTH ins.	VITAL CAPACITY	STANDARD VITAL CAPACITY	PERCENTAGE DEVIATION from STANDARD
3	23	1050	(1352)	-22
6	23	1150	(1352)	15
1	23¼	1100	(1386)	21
7	24¼	1220	1527	20
13	24½	1350	1563	14
17	24½	1250	1563	20
4	24¾	1050	1599	34
2	24¾	1100	1599	31
5	25	1400	1636	14
8	25	1460	1636	11
9	25	1220	1636	25
11	25	1000	1636	39
15	25	1300	1636	21
18	25	1400	1636	14
24	25	1650	1636	1
27	25	1450	1636	-11
31	25	1500	1636	8
10	25¼	1250	1673	25
14	25¼	1400	1673	16
16	25¼	1480	1673	12
26	25¼	1500	1673	10
19	25½	1450	1711	15
20	25½	1330	1711	22
21	25½	940	1711	45
23	25½	1800	1711	5
29	25½	1800	1711	5
33	25½	1600	1711	-6
37	25½	2060	1711	20
25	25¾	1450	1749	-17
12	26	1700	1787	5
CF		41410	48870	493 31

SERIAL NUMBER	STEM LENGTH ins.	VITAL CAPACITY	STANDARD VITAL CAPACITY	PERCENTAGE DEVIATION from STANDARD
				493
BF.		41410	48870	31
35	26	1400	1787	-22
34	26¼	1800	1826	1
22	26½	1400	1866	25
28	27	1520	1946	22
30	27	1600	1946	18
32	27	1610	1946	17
45	27	2300	1946	18
52	27	2550	1946	31
59	27	2700	1946	39
39	27¼	1800	1987	- 9
42	27¼	2100	1987	6
38	27½	2200	2029	8
40	27½	2190	2029	8
41	27½	2000	2029	- 1
43	27½	2000	2029	1
55	27¾	2150	2070	4
44	28	2050	2113	- 3
49	28	2600	2113	23
46	28½	2300	2199	5
47	28½	1950	2199	-11
48	28½	2190	2199	0
50	28½	1750	2199	20
51	28½	2100	2199	5
60	28½	2100	2199	5
53	29	2200	2287	4
54	29	2120	2287	7
57	29	2500	2287	9
56	29¼	2050	2332	-12
58	29½	2200	2377	7
36	31	2500	2658	6
61	34	4200	3275	28
		107540	115108	689
				210

Extreme Deviations -45 and 39 Range = 84

Total Deviations 899

Average Deviation $\frac{899}{61}$ = 14.7%

Net Total Deviation $\frac{115108-107540}{115108}$ = 6.6%

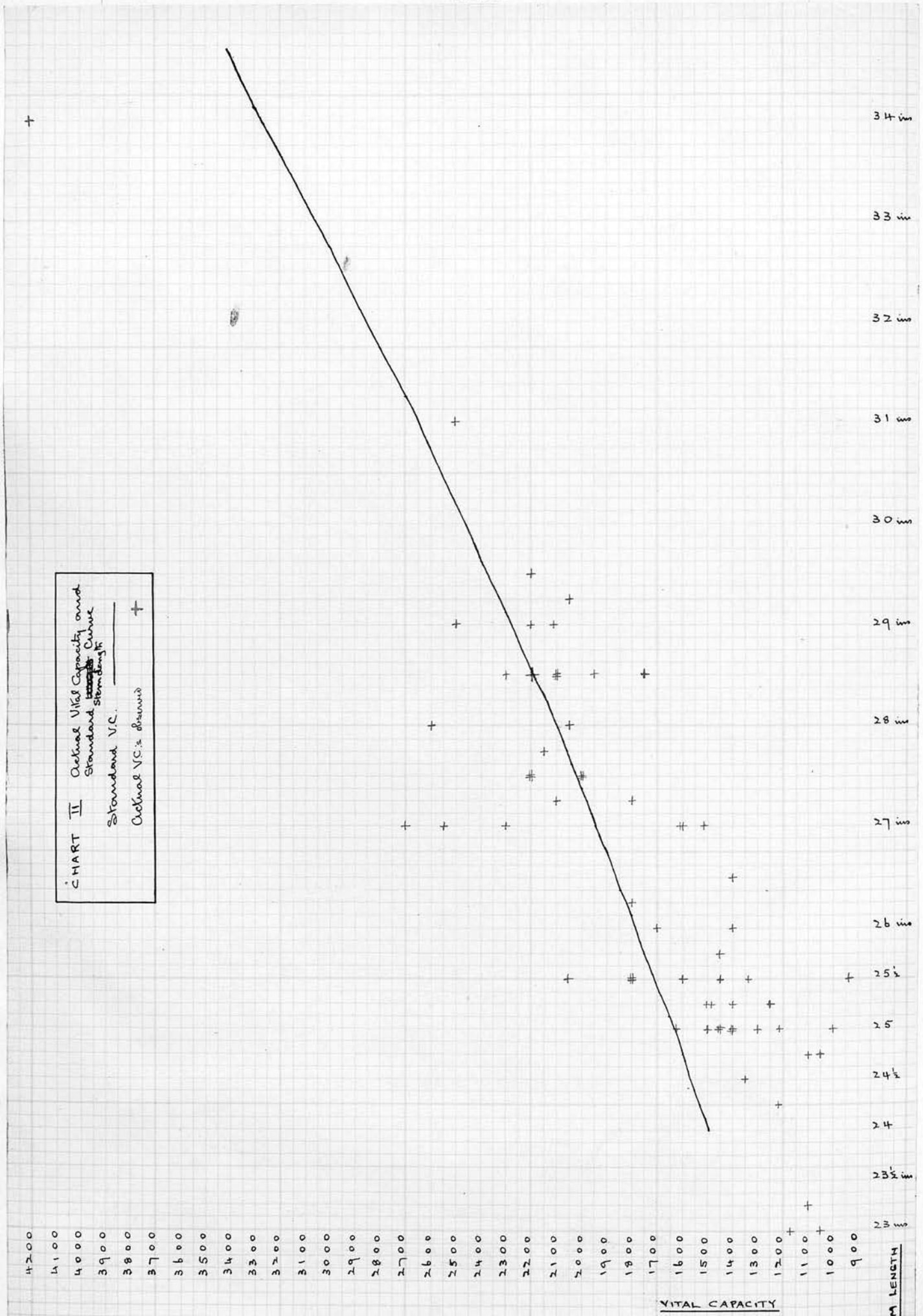


CHART II Actual Vital Capacity and Standard Curve
Standard V.C. ——
Actual V.C. & above +
4200 4100 4000 3900 3800 3700 3600 3500 3400 3300 3200 3100 3000 2900 2800 2700 2600 2500 2400 2300 2200 2100 2000 1900 1800 1700 1600 1500 1400 1300 1200 1100 1000 900
VITAL CAPACITY
34 ins 33 ins 32 ins 31 ins 30 ins 29 ins 28 ins 27 ins 26 ins 25½ 25 24½ 24 23½ ins 23 ins
STEM LENGTH

TABLE III.

N.B.

In this list the smallest chest measurement is placed first, and is followed in increasing gradation to the highest. It will be noted one chest measurement was not recorded.

It will be noted that at the foot of each TABLE the following summary is given:-

1. Extreme Deviations.
2. Total Deviations.
3. Average Deviation.
4. Net Total Deviation.

DIFFERENCE between ACTUAL VITAL CAPACITY and STANDARD VITAL CAPACITY as obtained from CHEST MEASUREMENT.

SERIAL NUMBER	CHEST MEASUREMENT ins.	VITAL CAPACITY	STANDARD VITAL CAPACITY	PERCENTAGE DEVIATION from STANDARD.
3	21	1050	1399	-25
1	21½	1100	1466	25
2	22¼	1100	1604	31
4	22½	1050	1604	35
5	22½	1400	1604	13
17	22½	1250	1604	22
21	22½	940	1604	41
15	22¾	1300	1639	21
6	23	1150	1675	31
7	23	1220	1675	27
10	23	1250	1675	25
23	23	1800	1675	7
8	23½	1460	1747	-16
11	23¼	1000	1747	43
19	23¼	1450	1747	17
24	23½	1650	1747	6
13	23¾	1350	1784	24
18	23¾	1400	1784	22
22	23¾	1400	1784	22
9	24	1220	1821	33
14	24	1400	1821	23
16	24	1480	1821	19
20	24	1330	1821	27
25	24	1450	1821	20
29	24	1800	1821	1
34	24	1800	1821	1
38	24	2200	1821	21
12	24¼	1700	1859	- 9
28	24¼	1520	1859	18
26	24½	1500	1897	21
CF		41720	51747	618 28

SERIAL NUMBER	CHEST MEASUREMENT ins.	VITAL CAPACITY	STANDARD VITAL CAPACITY	PERCENTAGE DEVIATION from STANDARD
				618
BF		41720	51747	28
27	24½	1450	1897	-24
30	24½	1600	1897	16
46	25	2300	1974	17
31	25½	1500	2053	-27
44	25½	2050	2053	0
33	25¼	1600	2093	24
35	25¾	1400	2093	33
49	25¾	2600	2093	24
39	26	1800	2133	-16
41	26	2000	2133	6
47	26	1950	2133	9
51	26	2100	2133	2
57	26	2500	2133	17
50	26¼	1750	2174	-20
37	26½	2060	2215	7
42	26½	2100	2215	5
53	26½	2200	2215	1
32	26¾	1610	2256	29
36	27	2500	2298	9
40	27	2190	2298	- 5
43	27	2000	2298	13
45	27	2300	2298	0
48	27	2190	2298	5
54	27	2120	2298	8
55	27¼	2150	2340	8
58	27¼	2200	2340	6
52	27½	2550	2382	7
59	28	2700	2469	9
60	28¾	2100	2601	19
61	33	4200	3414	23
56	-	-	-	-
Total		105490	118974	901 134

Extreme Deviations -43 and 24 Range = 67

Total Deviations 1035

Average Deviation $\frac{1035}{60}$ = 17.3%

Net Total Deviation $\frac{118974-105490}{118974}$ = 11.3%

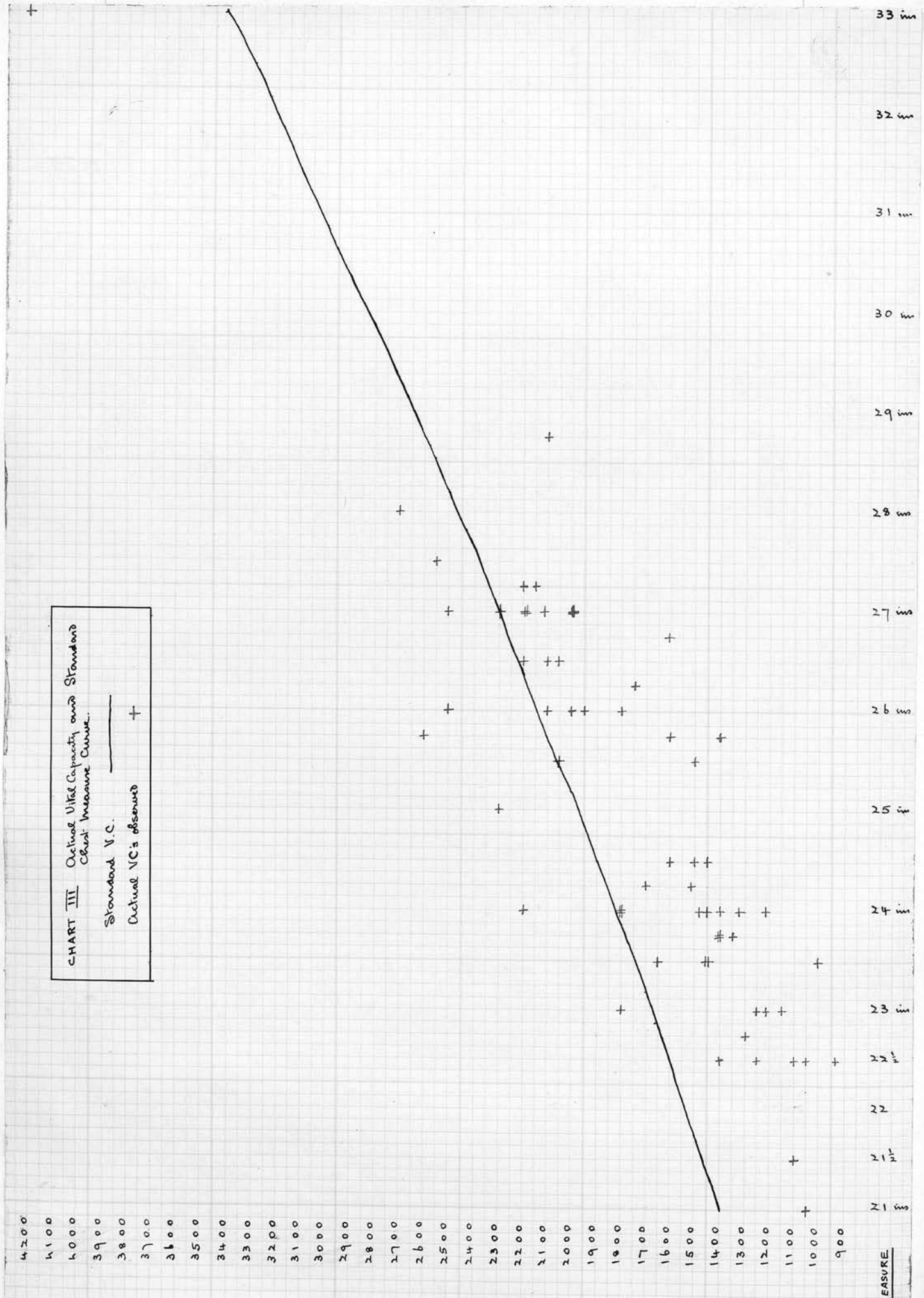


CHART III Actual Vital Capacity and Standard Chest Measure Curve.
Standard V.C. ———
Actual VC's observed +
VITAL CAPACITY
CHEST MEASURE
4200 4100 4000 3900 3800 3700 3600 3500 3400 3300 3200 3100 3000 2900 2800 2700 2600 2500 2400 2300 2200 2100 2000 1900 1800 1700 1600 1500 1400 1300 1200 1100 1000 900
33 ins 32 ins 31 ins 30 ins 29 ins 28 ins 27 ins 26 ins 25 ins 24 ins 23 ins 22½ 22 21½ 21 ins

The figures embodied in TABLES I., II. and III, were plotted out in chart fashion around the standard vital capacity curve for -

(a) Weight (Chart I).

(b) Stem Length (Chart II.)

(c) Chest Measurement (Chart III.) respectively. Each red cross represents the reading of one case. A double cross means two cases co-incide.

It will be noted that one boy was "head and shoulders" above the others in all his measurements, and as noted in the report of his case, (NO.61), this literally was so.

From these TABLES and CHARTS, it will be noted that:-

(1). Great differences in the actual vital capacity from DREYER'S Standard Tables exist, in respect of cases of equal measurement, be it weight, stem length, or chest measure.

(2). The results taken in relationship to chest measurement, are probably the most scattered, but, on the whole, are within narrower limits than the results by weight.

(3). The results in relationship to stem length, are less scattered, and are more closely grouped round the standard line, although the extreme individual differences are greater than in the others.

(4)/

(4). A study of the Tables, shows that the actual vital capacity in respect of equal weights, tends to rise with an increase in stem length, but not to the same extent with an increase in chest measure.

(5). The Tables also show the actual vital capacity in respect of equal stem lengths, and give no consistence in its variations.

(6). They also show the actual vital capacity in respect of equal chest measurement, which shows a slight tendency to rise with an increase in stem length.

It was next decided to bring the figures to a common basis for easier comparison.

The Actual Vital Capacity readings arranged in increasing order, were taken as the basis, and the percentage deviation above and below the standard line, is shown under the three headings of : -

A. = Weight

B. = Stem Length

C. = Chest Measurement.

These figures are embraced in TABLE IV.

COMPARATIVE DEVIATIONS of VITAL CAPACITY from the THREE STANDARDS.

SERIAL NUMBER	VITAL CAPACITY	PERCENTAGE DEVIATION from STANDARD.		
		WEIGHT A	STEM LENGTH B	CHEST MEAS. C
21	940	49	45	41
11	1000	42	39	43
3	1050	33	22	25
4	1050	35	34	35
1	1100	27	21	25
2	1100	28	31	31
6	1150	32	15	31
7	1220	28	20	27
9	1220	28	25	33
10	1250	27	25	25
17	1250	30	20	22
15	1300	26	21	21
20	1330	28	22	27
13	1350	23	14	24
5	1400	16	14	13
14	1400	20	16	23
18	1400	23	14	22
22	1400	24	25	22
35	1400	31	22	33
19	1450	21	15	17
25	1450	22	17	20
27	1450	23	11	24
8	1460	14	11	16
16	1480	17	12	19
26	1500	20	10	21
31	1500	23	8	27
28	1520	19	22	18
30	1600	17	18	16
33	1600	20	6	24
32	1610	18	17	29
24	1650	11	1	6

SERIAL NUMBER	VITAL CAPACITY	PERCENTAGE DEVIATION FROM STANDARD.		
		WEIGHT A	STEM LENGTH B	CHEST MEAS. C
12	1700	1	5	9
50	1750	25	20	20
23	1800	3	5	7
29	1800	5	5	1
34	1800	11	1	1
39	1800	13	9	16
47	1950	15	11	9
41	2000	6	1	6
43	2000	9	1	13
44	2050	8	3	0
56	2050	15	12	-
37	2060	0	20	7
42	2100	4	6	5
51	2100	10	5	2
60	2100	19	5	19
54	2120	11	7	8
55	2150	10	4	8
40	2190	5	8	5
48	2190	4	0	5
38	2200	6	8	21
53	2200	7	4	1
58	2200	12	7	6
45	2300	2	18	0
46	2300	2	5	17
36	2500	23	6	9
57	2500	2	9	17
52	2550	8	31	7
49	2600	13	23	24
59	2700	5	39	9
61	4200	22	28	23
	107540	963	689	901
		88	210	134

	A	B	C
Range of Deviation	72	84	67
Total Deviations	1051	899	1035
Average Deviation	17.2%	14.7%	17.3%
Net Total Deviation	12.9%	6.6%	11.3%

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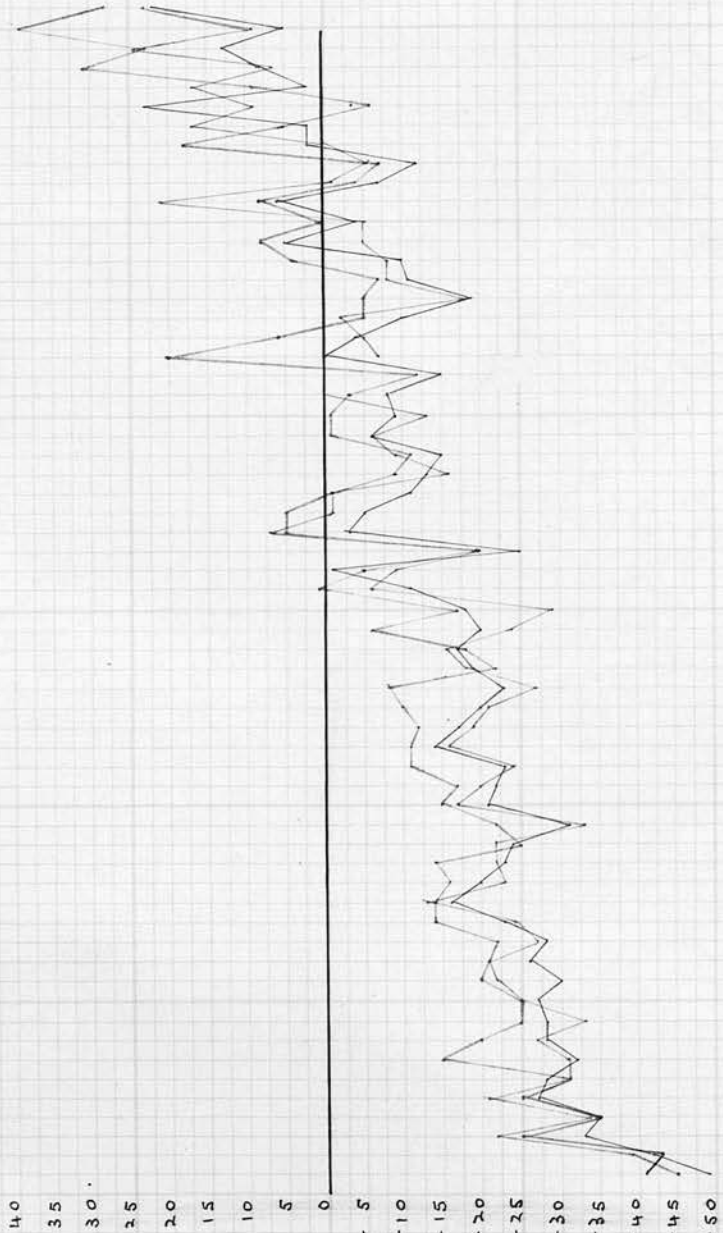
CHART VII
Combination of Crops IV, V & VI



PERCENTAGE DEVIATION FROM STANDARD

In this TABLE a summary is given showing:-

1. Range of Deviation.
2. Total Deviation.
3. Average Deviation.
4. Net Total Deviation.

Four CHARTS are also appended to show the results obtained in a more graphic form.

CHART IV. in red ink, shows the Percentage Deviation of Actual Capacity from Standard, as obtained from WEIGHT, arranged in order of increasing Actual Vital Capacity.

CHART V. in blue ink, shows the same when STEM LENGTH is used as the basis for Percentage Deviation of Actual Vital Capacity.

CHART/

CHART VI, in green ink, similarly depicts percentage deviations in actual vital capacity, when CHEST MEASUREMENT is taken as the standard.

CHART VII. gives the three curves together in their respective colours.

From TABLE IV. and CHARTS IV. to VI., it will be seen that the observations based on TABLES I. to III. are confirmed, in that the results based on STEM LENGTH, show a much closer average than the other two, the net deviation being only 6.6%.

The other two are similar in character, but on account of more plus deviations, the results based on CHEST MEASUREMENTS show a smaller net deviation than the results by weight, the percentage being 11.3% and 12.9% respectively.

It will be noted that the total deviations are as follow:-

	STEM LENGTH	CHEST MEASURE	WEIGHT.
Plus Deviations =	210	134	88
Minus " =	689	901	963
	899	1035	1051

These/

These figures again confirm the order in which the different series most closely approach the normal standard, and the totals show that the irregularities are much less in number when the standard is based on STEM LENGTH.

In CHART VII. where the curves of the three previous Charts are superimposed, we see clearly that, almost throughout, the actual vital capacity shows highest when compared with the standard obtained from stem length, and lowest when compared with the standard obtained from weight, having a midway position when compared with standard obtained from chest measurement, but nearer to that of weight.

In amplification of TABLE IV. a series of figures were obtained by using "combined standards", e.g. weight and stem length etc., and comparing them as before with the actual vital capacity readings. These additional figures are given in TABLE V. with the 'deviations' sommarised at the foot of the TABLE.

TABLE/

COMPARATIVE DEVIATION of VITAL CAPACITY from the different COMBINED STANDARDS.

SERIAL NUMBER	VITAL CAPACITY	PERCENTAGE DEVIATION FROM STANDARD			
		WEIGHT & STEM LENGTH a	WEIGHT & CHEST MEAS. b	STEM LENGTH & CHEST MEAS. c	WEIGHT STEM LENGTH CHEST MEAS. d
21	940	47	45	43	45
11	1000	41	43	41	41
3	1050	28	29	24	27
4	1050	35	35	35	35
1	1100	24	26	23	24
2	1100	30	30	31	30
6	1150	24	32	23	26
7	1220	24	28	24	25
9	1220	27	31	29	29
10	1250	26	26	25	26
17	1250	25	26	21	24
15	1300	24	24	21	23
20	1330	25	28	25	26
13	1350	19	24	19	20
5	1400	15	15	14	14
14	1400	18	22	20	20
18	1400	19	23	18	20
22	1400	25	23	24	24
35	1400	27	32	28	29
19	1450	18	19	16	18
25	1450	20	21	19	20
27	1450	17	24	18	19
8	1460	13	15	14	14
16	1480	15	18	16	16
26	1500	15	21	16	17
31	1500	16	25	18	19
28	1520	21	19	20	20
30	1600	18	17	17	17
33	1600	13	22	15	17
32	1610	18	24	23	21
24	1650	5	9	3	5

SERIAL NUMBER	VITAL CAPACITY	PERCENTAGE DEVIATION FROM STANDARD			
		WEIGHT & STEM LENGTH a	WEIGHT & CHEST MEAS. b	STEM LENGTH & CHEST MEAS. c	WEIGHT STEM LENGTH CHEST MEAS. d
12	1700	3	5	7	5
50	1750	23	23	20	22
23	1800	1	2	6	3
29	1800	0	3	2	0
34	1800	6	6	1	4
39	1800	11	15	13	13
47	1950	13	12	10	12
41	2000	4	6	4	4
43	2000	5	11	7	8
44	2050	6	4	2	4
56	2050	14	-	-	-
37	2060	10	4	7	4
42	2100	1	5	1	1
51	2100	8	6	4	6
60	2100	12	19	12	14
54	2120	9	10	8	9
55	2150	3	9	2	5
40	2190	7	0	2	3
48	2190	2	5	3	3
38	2200	7	14	15	12
53	2200	6	4	3	4
58	2200	10	9	7	8
45	2300	10	1	9	7
46	2300	4	10	11	8
36	2500	9	16	2	9
57	2500	6	10	13	9
52	2550	20	8	19	15
49	2600	18	19	24	20
59	2700	22	7	24	18
61	4200	25	23	26	24
		827	932	786	833
		140	110	161	132

	a	b	c	d
Range of Deviation	72	68	69	69
Total Deviations	967	1042	947	965
Average Deviation	15.9	17.4	15.8	16.1
Net Total Deviation	9.8	12.1	9.0	10.3

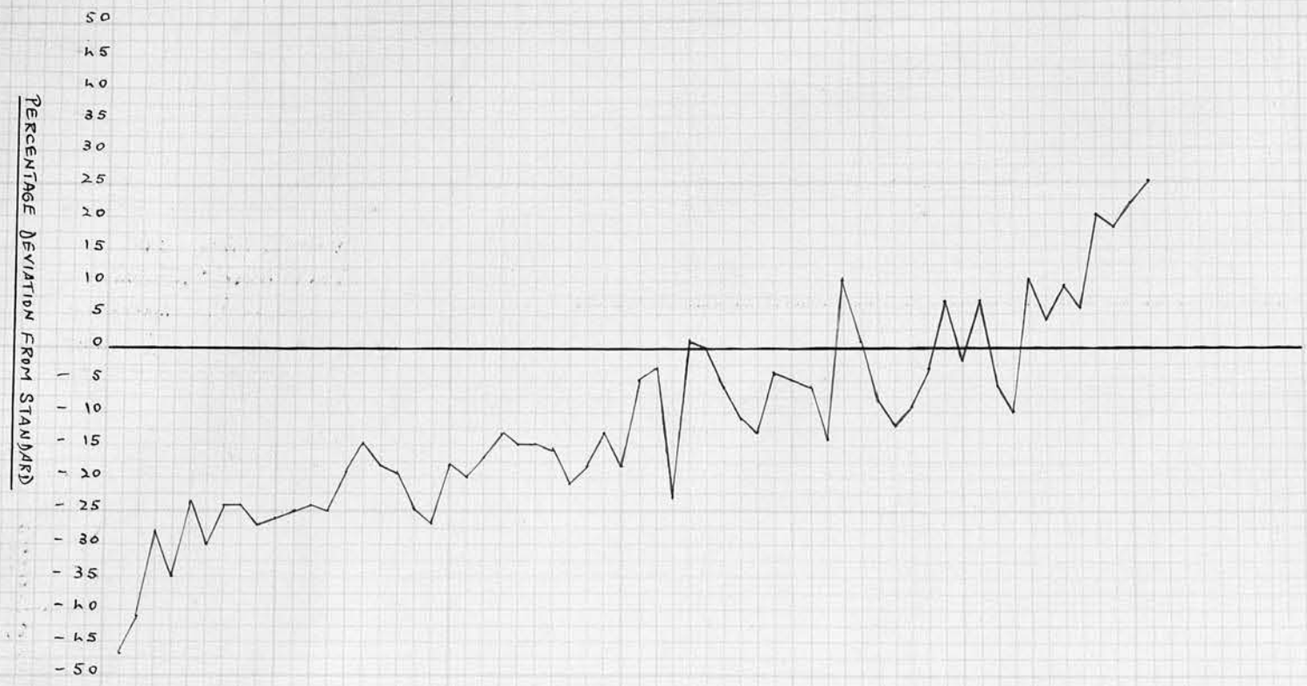
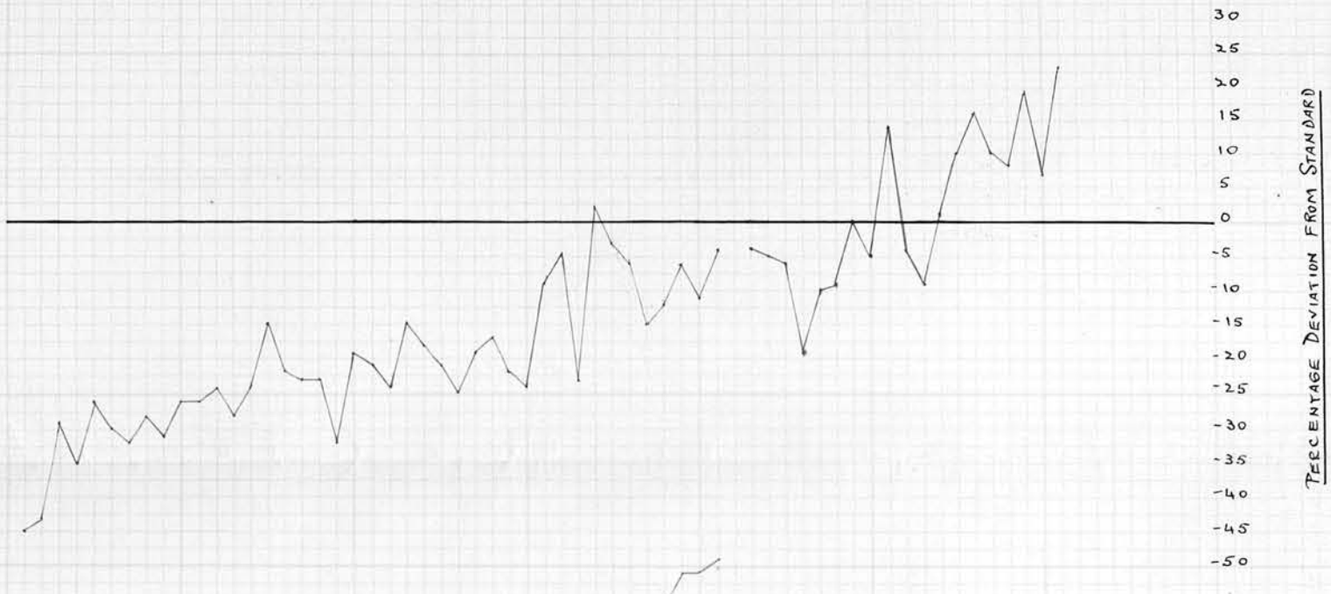


CHART VIII
Percentage Deviation of Actual Vital Capacity from Standard as obtained from WEIGHT and STEM LENGTH combined
Arranged in order of increasing Actual V.C.

CHART IX
Same as VIII but Standard obtained from
WEIGHT and CHEST MEASURE



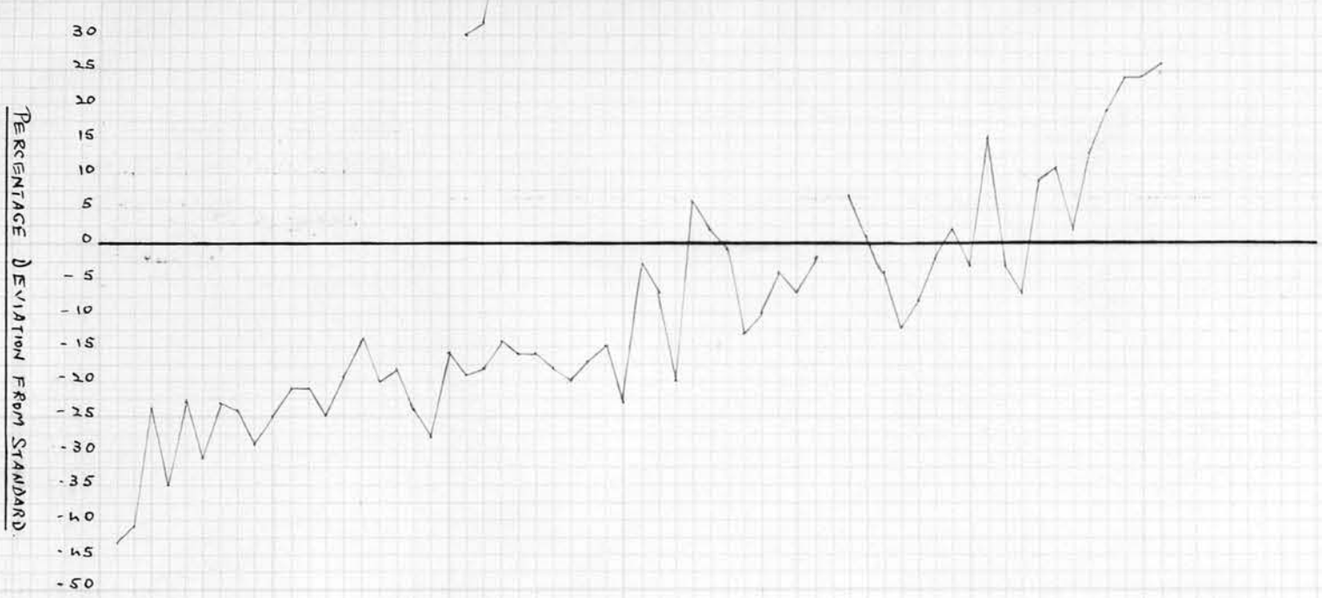
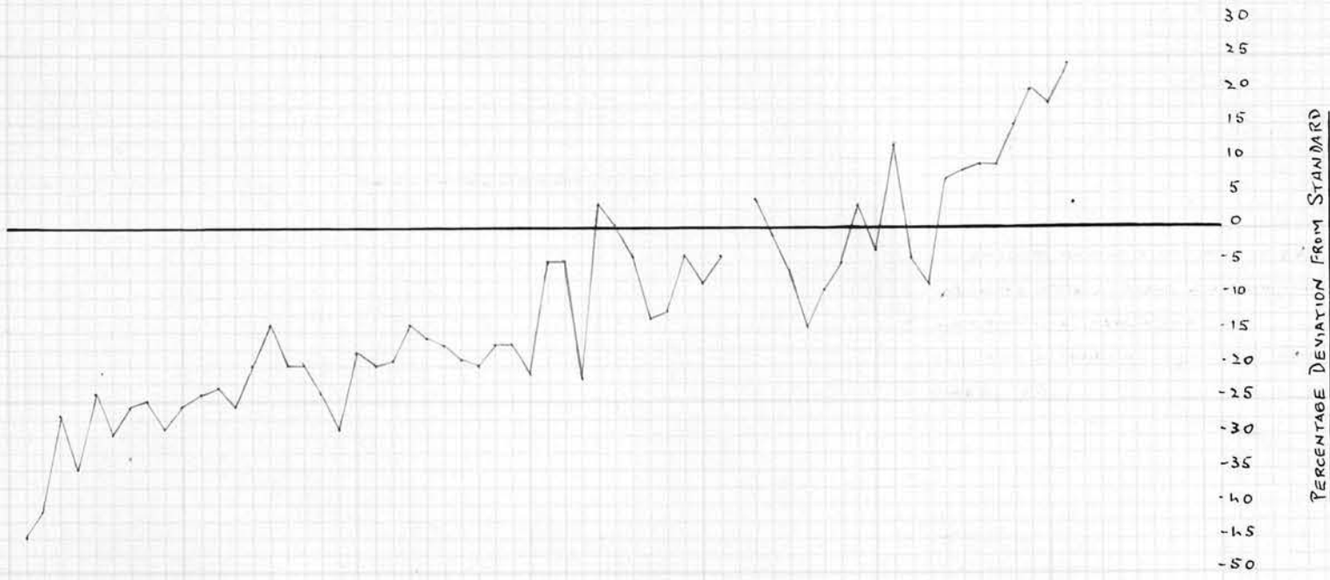


CHART X
Same as VIII but Standard obtained from
STEM LENGTH and CHEST MEASURE

CHART XI
Same as VIII but Standard obtained from WEIGHT, STEM LENGTH and CHEST MEASURE combined



These TABLES are arranged in graphic fashion in CHARTS XII, XIII, XIV and XV, CHART XII being a composite CHART, in which the three others are superimposed.

It/

It will be seen that in the "POSITIVE" group, the average deviation from the standard is much less than in the "NEGATIVE" group. In other words the actual vital capacities more nearly approach the normal standard in all cases.

The net deviation in all cases is as follows:

	POSITIVE	NEGATIVE
Employing WEIGHT STANDARD	-9.4%	-15.9%
" STEM LENGTH "	-3.3%	-9.2%
" CHEST MEASUREMENT	-7.6%	-10.8%

As before, we find in both the "POSITIVE" and "NEGATIVE" groups, that the standard obtained from the stem length is nearest the actual values of DREYER'S standard.

It is also to be noted, that in the "POSITIVE" group, the actual values cross the standard line at an earlier point, and also show a greater number above standard, than in the"NEGATIVE" group.

In the "NEGATIVE" group on the other hand, it will be noted, that in all cases there is a much more regular progression, specially in that based on the weight standard. This indicates that, although the negative groups, on the whole, are below the normal/

normal standards, they are without the more violent irregularities, and can be more easily related to the standard.

It is also to be noted that, speaking broadly, residence in School shows a steady rise in fitness, as tested by the measurements made.

The writer has received material assistance from Mr Charles Douglas, F.F.A. in the preparation of the above statistics. He is indebted to Mr Douglas for the preparation of the CHARTS.

b/

b). Cervical Glands:

PRESENCE of CERVICAL GLANDS in relation to PIRQUET REACTIONS.

The cervical glandular enlargement, as recorded in the CHARTS, was grouped into four headings in relation to the PIRQUET reaction. (See VOL.II).

CLASS I.

Glands obviously enlarged, or distinctly numerous, with a positive PIRQUET Reaction.

CLASS II.

Glands obviously enlarged, or distinctly numerous, with a negative PIRQUET Reaction.

CLASS III.

Glands very tiny with positive PIRQUET reaction.

CLASS IV.

Glands very tiny, or absent, with a negative PIRQUET reaction.

In classifying these cases, it will be remembered, that a very strict examination of the anterior cervical region was carried out, and, therefore, cases with what might be termed small glands, are included in "Glands obviously enlarged". Tiny, almost imperceptible/

imperceptible glands, are in CLASSES III & IV.

The result is as follows:-

CLASS I	CLASS II	CLASS III	CLASS IV.
28	16	3	14

This, of course, is what one would expect to find viz:- that the coincidence of enlarged glands with a positive PIRQUET test and tiny glands with a negative PIRQUET test, would embrace the largest number, viz:- 42. (CLASSES I & IV together).

The three cases with tiny glands and a positive PIRQUET test are, in a sense, exceptional boys; one of them is NO. 61, the 'giant' of the School, who was in every way very fit.

Another NO. 60, was operated on for an acute empyema, a year before being examined. The other, NO. 52, was a very fit boy, and all his vital capacity readings were above normal, specially the stem length record. His hilus shadow on the right side is well defined, but in spite of this, both myotatic irritability and vaso-motor paralysis of the chest muscles were present.

The next question to be summarised, is the relationship/

relationship of the PIRQUET reaction to the presence of myotatic irritability and vaso-motor paralysis.

In 18 Cases some degree of myotatic irritability was noted, and in 8 cases the reaction to the PIRQUET test was negative, while in 10 the reaction was positive.

In 30 Cases some degree of vaso-motor paralysis was noted and in 14, the reaction to PIRQUET'S test was negative, while in 16 the reaction was positive.

This result was quite to be expected as a positive PIRQUET test has no special relation to the state of toxaemia, as a healed lesion may give a positive reaction, and toxic phenomena may be due to other causes than Tuberculosis.

II. CO-RELATION between PHYSICAL EXAMINATION and RADIOGRAMS.

We have now to consider the results of the physical findings in relation to the X-Ray picture.

When this work was begun, the writer was hopeful something might be made out of careful spinal auscultation, but he realised that diverse views are expressed in the literature, terminology not even being/

being constant; e.g. the meaning of D'ESPINE'S sign. As was pointed out, no attempt was made to estimate the value of this sign, but rather to record other phenomena of spinal auscultation, which were at least, easily defined, or quite frankly indefinite.

The clinical records show, in the CHARTS, much deviation in results obtained. The most surprising point being that the various changes in the auscultatory phenomena, are audible generally speaking, at a much lower level than he was led to expect. As was to be expected, the Whispered Voice phenomenon, was the most stable and most frequently showed a clear cut break in quality and intensity.

The Bronchial type of breathing came next, from the point of view of definite changes on going down the spine, and as was to be expected, most variation and indefiniteness was encountered with the Spoken Voice phenomenon. It is a curious fact, but in only one case were the auscultatory phenomena sharply broken in type and intensity at the 7th cervical vertebra. There was nothing special to indicate the reason for this.

It is, of course, impossible to analyse all the cases in detail. Two attempts were made to do so, to/

to test the question of co-relation between X-Ray findings, physical signs (including spinal auscultation), and the PIRQUET reaction, but no co-relation whatever could be determined.

Here and there an impaired percussion note coincides with a slightly diminished luminosity, over the same area in the chest. On the other hand, an impaired interscapular note may compare with an enlarged hilus shadow in one case, while in another there will be rather a faint hilus, or, in another case a dense hilus may be present without any impairment of percussion note.

These points may be made clear by taking a few examples.

In CASE XLIII, the spinal auscultatory phenomena change their character very high up, for this group of CASES, and in CASE XXX, the auscultatory phenomena over the spine, show no clear cut change, and what change there is, begins low down, and takes place slowly. The boys are about the same age, viz:- 13 and 12, and their Vital Capacity readings are close to the normal figures of DREYER'S Tables, for their size. When their X-Rays are examined, however, the older boy, (NO. XLIII), has a clearly defined root shadow, with definite branching from it, while the younger boy, (NO.XXX), has a poorly defined root shadow, with ill defined branching. In the former, the PIRQUET test is negative, while in the latter it is positive.

If/

If two others are taken of the same age, 9, in which the spinal auscultation phenomena are similar, (NOS. XIII and XXXIII), and in whom the decrease in Vital Capacity is about equal, we find again a difference in the X-Ray reading. This time, the boy who has a positive PIRQUET test, shows a faint, but well defined right hilus shadow, while the boy who gives a negative PIRQUET test, gives a more mottled, ill defined hilus shadow, which, however, stands out more clearly than the previous one.

If two more cases are taken of the same age, 10, with a similar stem length $(25\frac{1}{2})_{A}^{\text{ins.}}$ both giving Vital Capacity for this reading above normal, and both with positive PIRQUET reactions - faintly in one, - (NO.XXIX), and marked in the other, (NO.XXXVII), while in both the spinal auscultation phenomena approximate, but do not quite coincide. We find, on turning to the Radiograms, that in NO.XXIX, the root shadow is diffuse with a central annular shadow and well marked branching. The other, NO.XXXVII, shows a faint, but rather more defined root shadow on both sides with a minimum of branching. This latter case has a higher percentage in vital capacity reading, and no myotatic irritability or vaso-motor paralysis, despite this more markedly positive PIRQUET reaction.

Further examples could be given, but these suffice/

suffice to indicate the lack of relationship in the various findings.

From a general survey of this aspect of the work, one is inclined to agree with the Committee, who undertook the investigation of over 500 children in the United States, and published their results in July 1922. There are no strictly normal X-Ray shadows, while there are no strictly normal Physical signs, when dealing with children. Both radiograms and physical findings must deviate within certain, rather wide fields. This is only to be expected, when one considers, that one is dealing with growing organisms.

III. RADIOGRAPHIC INTERPRETATIONS.

Finally, from a study of the RADIOGRAMS alone the writer has been impressed with the fact, that in every case, he has noted what he terms "opaque dots"of varying size, in every photograph. In some, they are difficult to discover, in others quite easy. The significance of these areas is not clear. It has been suggested, that they are healed tuberculous lesions, but, it will be noted in the two pairs of RADIOGRAMS taken in full inspiration and expiration, the opaque areas change in number and character. It is hardly conceivable that they are all healed tuberculous lesion, in/

in view of the frequency of negative PIRQUET findings in this series. The curious, circular arrangement of these areas will be noted in many radiograms. It has been suggested that they are blood vessels, seen in transverse section, or bronchi seen at right angles. It is difficult to say, but the writer is inclined to favour the blood vessel theory, always, of course, excepting more definite opaque, circular shadows, near the hilus, which are more likely to be due to some healed inflammatory reaction.

Perhaps the most striking fact revealed in a study of these radiograms, is the absence of similarity of the root shadow, which gives support to the view that well defined root shadows are, more probably, pathological entities, than some would have us believe. If they were due, as OVEREND (82), says, in the main, to blood vessels, then one would expect the shadow to be of a more standard type. More co-operation, and records of results, from a joint study in the X-Ray department and the post mortem room, are required, to clear up this matter. In the meantime, one is tempted to suggest that radiograms must, on no account, be interpreted alone, without a full clinical consideration of the case. The Roentgen rays reveal shadows - very valuable shadows - but such shadows are open to different explanations, when view in relation to all the facts presented by the patient, whose case is under consideration.

IV. CONCLUSION.

In conclusion, it may be stated, that the above study includes a short anatomical and pathological review of the glandular system of the neck and thorax, with special reference to tuberculous infection. Thereafter, short reviews are given of certain methods of clinical investigation, followed by a full description, with radiograms in most of the CASES, of 61 healthy schoolboys. These results have been examined in the light of DREYER'S tables, and deductions drawn therefrom. In the course of this study and analysis, it has become obvious, that the clinical investigation of the glandular system is of paramount importance, when looking for evidence of Tuberculous Infection. It has, also been seen, that considerable variety of radiographic appearances could be demonstrated. These appearances however, could not be co-related to any definite physical signs. There is considerable variation, within certain limits, of both physical findings and radiograms, in boys who are perfectly fit, in the sense that they are able to carry on the normal mental and physical activities in a school where they are well housed, well fed, and well educated. This corresponds to the findings/

findings of the American Committee of three Clinicians and three Radiologists.

A study of the cases in relation to the PIRQUET reaction has shown that the boys who give a positive reaction are, on the whole, more sturdy than those who do not, when analysed from the weight, stem length and chest measurement point of view, in respect of vital capacity readings.

Perhaps the most striking, individual finding has been the difference obtained by spinal auscultation from that recorded by other observers. It will be noted in the present series that "whispered voice" and "bronchial breathing" terminate at a lower spinal level, than is usually recorded, in almost every case here reported.

Another general observation with which I have been impressed, may be noted. When this study was begun I hoped that some standard deviations might be discovered, to co-relate PIRQUET reactions, radiograms, vital capacity readings, and the results of physical examinations. This has not been so. DREYER'S tables have not corresponded in the younger boys, and marked individual deviations have been present all along the line.

This irregularity of result shows again, quite clearly, the old truth that assessment of physical fitness, or the evidence of tuberculous infection or disease/

disease, cannot be determined by one isolated observation. Of set purpose one vital question in the clinical investigation of these cases has been omitted - viz: the previous history. It is borne in on one, more and more, that the determination of physical fitness, in relation to tuberculosis, can only be found by a complete review of the whole individual situation. The final opinion can only be expressed by the physician, after a due sifting of all the evidence placed before him, derived from the case history, clinical examination, and results of special tests.

Finally, it appears clear to me, that tuberculous infection in school children, requires close study and full investigation, both by clinical means and special tests. One is apt to be lulled into a sense of false security, at this age, because of the admittedly low mortality from tuberculosis. It is - as it were - a transition stage between the primary and secondary phase of tuberculosis. It is, therefore, the best time to carry out anticipatory measures when resistance is normally good, and a degree of disciplined life is being carried through. Evidence of infection must be searched for, as it is not the age when a patient comes to the physician on account of ill health.

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